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# FOREST RESEARCH

## BI-MONTHLY REPORT

October 1, 1940

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# FOREWORD

For an academic institution as truly as for any government it is vitally important that we should keep our main purpose continually before our eyes and set an established course. From that course deviations will be desirable as conditions change, but they should be made consciously and intelligently, their value estimated relative to their cost. Nothing is more wasteful than haphazard drift and in these times it involves factors of positive danger.

From: Report of the President of Yale University, 1938-1939.

# GENERAL

## Allegheny

Personnel. Mitchell has reported to the Upper Susquehanna Survey as acting senior representative. Hetzel resigned August 31 to accept private employment. A. B. Crow and Carl Ostrom left in September on educational furlough to attend Yale School of Forestry.

The Advisory Council of the Allegheny Station held a meeting at Kane on July 19 and 20 with Mr. Clapp and Mr. Larrimer from the Washington Office present. The duties and functioning of the Council were explained by Mr. Clapp and discussed by the members present. On the second day the members had a short field excursion on which the problems of the Plateau were pointed out on the ground and the Kane Experimental Forest was visited.

Thirty-five members of the Allegheny Station Staff participated in a conference to discuss the program recommended by the Forest Service to the J. C. C. A particularly lively discussion of regulation, lead by Director Zon of the Lake States Station, occurred.

The Pennsylvania Bi-Centennial Celebration. Shirley and Forbes assisted Doctor Schramm, Head of the Botany Department, University of Pennsylvania, in arranging a series of three symposia dealing with various conservation problems.

The Director made a number of suggestions as to objectives for the Pennsylvania Community Forests Council that were discussed at the last meeting of the Program Committee. He also participated in a three-day inspection of various State forest lands, in company with various forestry officials of the State.

Tionesta Natural and Scenic Area. On July 31, 1940, the Forest Service formally set aside the Tionesta Natural and Scenic Area on the Allegheny National Forest.

Cooperation. Forest management men from the Lake States, Allegheny, and Northeastern Stations participated in an informal field tour of the northern hardwoods type in Pennsylvania, New York, and New England during the last week of June.

Hough spoke before the botanical conference forum held at the Allegheny School of Natural History on the Allegany State Park, New York.

Little participated in preparing a report outlining "A Forestry Program" for the State of New Jersey, which has been submitted to the Regional Coordinating Committee.

Branch Station Development. WPA projects were set up and approved for development work on both the Beltsville and Standing Stone Experimental Forests. At Beltsville, national defense project requirements have necessitated temporary suspension of our work. At Standing Stone, road development work for protection and future forest utilization use is the main work project under way.

## Appalachian

Personnel. Dr. H. H. Biswell was transferred to the Appalachian Station from the California Forest and Range Experiment Station, effective September 1. He will be in charge of the Station's new forest grazing project under the Division of Range Research.

## California

Personnel. Dr. Hereford Garland was appointed to the Products Division staff in June, to carry on the woods and mills studies activities. He was an assistant on this work at different periods while a student in the Department of Forestry, University of California, and comes here from the Division of Horticulture and Forestry, University of Arkansas, where he was engaged in teaching and research following graduate study at Washington University, St. Louis, Missouri.

## Central States

Cooperation: Ohio Woodland Survey. The first report, "Forest Resources of Wayne County, Ohio", was issued about June 1, 1940.

During the latter part of September, two additional sets of volume table data arrived from the District Supervisor's office in Dayton, Ohio. The reworking of other volume table data provided by the Survey permitted the issuance of nine tables discussed later in this report.

Statistical. A. G. Adman, statistician for the Station, and O. D. Diller of the Ohio Woodland Survey have cooperated on the compilation, statistical analysis, and publishing of volume tables for yellow poplar, cucumber tree, basswood, northern red oak, sugar maple, black walnut, white ash, and white oak measured in Stark County, Ohio.

Ohio State University. On July 29, J. A. Hall gave the first of an indefinite series of talks on forestry over Station WOSU during the University's weekly farm night program sponsored by the College

of Agriculture. His subject was "How to get the most out of your woods." The second talk, "What is a well-stocked woods?" was given on August 12, and "Why not to pasture the woods" on September 16. These talks are to be given on the second Monday of every month between 8:00 and 10:00 p.m.

Library. The task of cataloging and classifying Station library material has been undertaken through a WPA library project supervised by a trained librarian. Satisfactory handling of Station library material is possible by the present project, with only a limited amount of time by technical staff members needed to check librarian's work on technical material.

## Intermountain

Visitors. C. M. Donald of the Department of Agriculture of Australia is just finishing a four-week visit with the Intermountain Forest and Range Experiment Station, studying the methods by which range research is conducted. He has visited the three main experimental areas at the U. S. Sheep Experiment Station near Dubois, Idaho; the Great Basin Branch Station in Ephraim Canyon; and the Desert Branch Station, 50 miles west of Milford, Utah. He also spent several days in and near Ogden becoming acquainted with the manner in which field data are compiled and with office work generally.

Assistant Chief C. L. Forsling spent a few days in August at the Boise Basin Branch Station inspecting the work in forest management being done there and discussing plans for the future. With W. R. Chapline, and members of the range staff, he considered the range management work being conducted at the U. S. Sheep Experiment Station near Dubois, Idaho.

Personnel. C. M. Aldous, Associate Biologist of the Fish and Wildlife Service, arrived in Ogden August 31 preparatory to establishing his permanent headquarters with the Intermountain Forest and Range Experiment Station, where he will have charge of the section dealing with cooperative wildlife research work that will be dovetailed into several of the Station's investigative projects.

Bertram G. Goodell, Junior Forester, was transferred from the Northeastern Forest Experiment Station to the Intermountain Station and assigned to the division of Forest Influences during the early summer. He attended a special summer session at the Colorado State Agricultural College for advanced study in Hydraulics and Hydrology.

Ira Clark, Assistant Conservationist, took leave to engage in graduate work in Ecology and Statistics at Iowa State College from January 2 to March 23, 1940.

Meetings: Grassland Conference. The Western Regional Grassland Conference was held in Salt Lake City, Utah July 15-17. Director Bailey was Chairman of the Program Committee and presided over the conference. The Forest Service was represented on the program by C. L. Forsling, who read a paper on Research in Range Management; Dr. Wm. G. McGinnies - Range Management; Dr. George Stewart - Relation of Farm Pastures to Range; and Reed W. Bailey - The Place of Grass in Soil and Water Conservation. W. R. Chapline assisted with arrangements and contributed to the discussions.

Eighty-four members of the conference spent July 17 in an inspection of the influence and reseeding work at the Wasatch Branch Station (Davis County Watershed).

Phosphate Conference. The Western Phosphate Conference under the auspices of the Committee on Preservation of Phosphate Deposits and their Utilization, Association of Land Grant Colleges, was held in Ogden September 5-7. The Intermountain Station cooperated with the Utah Agricultural College in conducting the meetings and field trips.

Mural. Through the cooperation of the WPA Arts Project, a mural has been painted which will occupy a permanent position in the headquarters of the Intermountain Station.

This mural, titled "I Will Lift up Mine Eyes to the Hills From Whence Cometh My Help", Psalm 121:1, pictures a characteristic intermountain scene, which reveals the relationship between man's work in the desert valleys and the mountain resources. The pioneers to the arid West established themselves at the mouths of canyons near the base of the mountains -- in part because of the fertile soil and favorable climates, but primarily because the adjacent mountains provided timber, forage, recreation, and above all water upon which they built a civilization. The title of the picture is selected not only for its spiritual significance, but also as an expression of recognition by a people in arid lands of dependence on their mountains.

The mural was painted by Howell Rosenbaum, well known Ogden artist, and will be loaned to the Department for display in the patio of the Agircultural Building in Washington, after which it will be hung on the fourth floor of the Forest Service Building in Ogden.

Lake States

Zon attended the Bicentennial Celebration of the University of Pennsylvania during the latter part of September as the official representative of the Forest Service. At the celebration he acted as chairman of one of the three symposia devoted to fundamental aspects of conservation. The subject was natural vegetation as a guide to current agricultural and forest practices. While in Philadelphia a day and a

half was spent with the staff of the Allegheny Forest Experiment Station discussing the economic study of the anthracite region and public regulation of private land.

Pacific Northwest

Experimental Forests. Two of the five experimental forests have been entirely closed all summer -- Blue Mountain and Port Orford Cedar. Cascade Head, so far as technical work is concerned, has been practically closed but the ERA crew continued surfacing the development roads throughout the summer and made good progress. McComb returned September 23 to resume ERA technical foremanship at this place.

At Wind River a change in personnel has been necessary because Walter Petersen has gone back to Yale for postgraduate work, his place being taken by Assistant to Technician William Allyn as foreman of our CCC squad.

At Pringle Falls the CCC side camp has worked primarily on building a dormitory for themselves but McKay as technical CCC foreman has successfully maintained the experimental work there and added some stand improvement sample plots.

Meetings. At the national meeting of the A.A.A.S. Munger gave a paper before the Ecological section on the cycle from Douglas-fir to hemlock and Isaac gave a paper at a joint meeting of the Ecological Society and the S.A.F. on the vegetative succession following logging in the Douglas-fir region. The paper illustrated the intimate relationship that exists between vegetative succession and natural regeneration and fire. It was based on the original cover records from 15 well distributed groups of natural reproduction sample plots, and was of particular interest because the published material in that field for the Douglas-fir region is very meager.

Southwestern

Personnel. Effective August 16, Crafts was promoted from Associate Forest Ecologist to Forest Economist, and transferred to the California Forest and Range Experiment Station. He had completed in June 1940 all resident work for a doctorate in Forest Economics at the University of Michigan.

Valentine, Junior Range Examiner, received his Bachelor of Science degree in Range Ecology and Range Management at the University of Arizona in June 1940, was selected as the outstanding student in the College of Agriculture, and was awarded the Paul Steere Burgess fellowship in that college. He is now assuming that fellowship, to earn his Master's degree in June 1941.

Special cooperative service to Texas A & M College. Last spring McGinnies, Chief of the Division of Range Research, was selected by Texas A & M College to teach a special 3-weeks' course in Range Ecology and Range Management on a schedule amounting to a full 3 hours' semester credit. The course was given from June 10 to 29, and based on the reports received from members of the faculty and the class, McGinnies' services were outstanding.

Bicentennial Celebration of the University of Pennsylvania. G. A. Pearson, Senior Silviculturist, was selected as one of the three representatives of the Forest Service to participate in the Bicentennial Celebration of the University of Pennsylvania, Philadelphia, September 16-21, 1940, the others being Shantz and Zon. Pearson's subject was "What Forest Trees Tell about Climate and Soil."

## FOREST ECONOMICS

### ECONOMIC-SOCIAL BENEFITS

Allegheny

Anthracite Survey. Field work in the forest inventory, conducted with WPA labor, was completed for half of Luzern County -- the "guinea-pig" county. By means of carefully drawn and highly simplified field instructions, painstaking selection of men for the job (local WPA officials have cooperated heartily in this), intensive training, and the customary periodic checks on performance of each crew, we have so far been fully able to attain Forest Survey standards of accuracy. Output has also been satisfactory, in spite of excessive travel time from our Kingston headquarters to the periphery of the county. The appointment of a full-time project head, paid from WPA funds, is expected shortly and will help to maintain the present high morale of the crews.

Because the object of the inventory is to obtain information which will show the possibility of sustained yield -- and continuous employment based on it -- in a county or comparable area, the sample taken is about 1/10 of 1 percent, which we hope will confine the error to 5 percent. Following a visit by Mesavage to the Appalachian and Southern Stations, we are laying plans to compute volumes of standing timber by "computation units" of 5 x 6 miles. This should enable us to inform inquirers of the amount of timber, of specified size and species, standing within a 25-mile haul of a designated manufacturing center. Supplemented by data next to be obtained as to labor requirements in forest industries, it should make possible

an estimate of the number of permanent jobs to be created by regulated use of the forests of a township, should that prove desirable. Accuracy will of course not be as great in such small units as in the county, but will be materially increased by use of the large-scale map of forest areas in Luzerne County now completed from the aerial photographs.

Our very competent staff of WPA draftsmen has compiled base maps of five counties, on the scale of the Geological Survey quadrangles. These are proving invaluable, because all the topographic quadrangles are hopelessly out of date so far as roads are concerned, and some of the older are in error with respect to topography. The aerial photographs, recent highway department maps, and latest township maps have been used in the compilation.

Girard visited Kingston briefly in September to assist us in checking the field crews, and our local volume tables. Field Assistant Kaufman, with WPA help, examined several mine prop yards as a preliminary to a study of prop weights in relation to size. Because props are commonly sold both by the piece and by the ton, we need to check existing converting factors for several species.

Field Assistants Noonan and Beck completed an examination of county records designed to show how much forest land is now county-owned as a result of long-standing tax delinquency; how much has reverted to the county, at least temporarily, as a result of tax sales under recent legislation; the size distribution of privately owned forest properties; and the average general property tax on forest land. Of immediate interest has been county policy toward land firmly in county ownership, which is convertible into community forests under existing law. If emergency labor is to be employed in planting, timber stand improvement, and similar measures not clearly designed to control erosion or forest fires, it must be on publicly owned land, of which there is relatively little in most counties of the anthracite region. The above studies do not encourage much hope that public ownership can be greatly expanded in the next couple of years, although the present situation is somewhat variable, and may change considerably as tax sales catch up with delinquency. In Luzerne County no tax sale had been held in the 28 years prior to 1940.

Southwestern

Colorado River Drainage Basin. A meeting of the Colorado River Drainage Basin Committee, jointly with that of the Bonneville Drainage Basin Committee, scheduled for September 2 at Glenwood Springs, was postponed until probably November. The Basin Chairman of the National Resources Planning Board has previously asked for recommendations for, against, or modifications in proposals by

the Bureau of Indian Affairs and Bureau of Reclamation for 24 water construction projects in the Colorado River Basin. Through correspondence with representatives of all interested bureaus of the Department of Agriculture, Director Upson, as Chairman of the U.S.D.A. group for the Colorado River Basin, supplied specific comment on 6 of these projects and requested that further time be allowed Departmental representatives on the remaining 18.

Special Gila River-San Carlos Reservoir Investigation. Four members of the Station staff have been engaged since June 1940, whole or part-time, in analysis of special data and technical assistance to the Subcommittee appointed by the National Resources Planning Board to investigate the situation surrounding the shortage of water in San Carlos Reservoir behind Coolidge Dam on the Gila River in central Arizona, which project was constructed in 1926 to provide irrigation water for 100,000 acres of land in the San Carlos project, 50 percent of which belongs to Indians and 50 percent to whites. The instructions to the Subcommittee read as follows:

> Report on the relations among land-improvement practices and the quality and quantity of water in the Gila Basin, Arizona and New Mexico. That analysis is to take into account all present and prospective land-management practices as they relate in any way to the amount and distribution of flow of streams, accumulation of water underground, the chemical quality of water, the transportation and deposition of silt in streams and in reservoirs, and the consumptive use of water by vegetation.

Members of the Subcommittee are Barton Jones, Consulting Engineer for Tennessee Valley Authority, Chairman; G. L. Parker, Section Chief, Geological Survey, Washington; Major A. B. Jones, Engineering Assistant to the Assistant Chief, Corps of Engineers, War Department, Washington; and Hugh G. Calkins, Regional Conservator, Soil Conservation Service, Albuquerque, New Mexico. Subcommittee workers and assistants from Federal agencies number about 15.

The work to date has consisted of more or less extensive field trips by the Subcommittee and interested Federal, State, and private agencies over the watershed above Coolidge Reservoir, and the assembling and special analysis of a large quantity of forest influences and similar data pertinent to the subject resulting from research at the Parker Creek Branch Station, and of administrative studies and research of other bureaus of Agriculture and of the War and Interior Departments.

The Subcommittee is directed to render its report by October 1. The outcome of this investigation may have direct bearing on future programs of research and construction work of upstream engineering character in the desert and semidesert regions of the United States.

Pecos River Joint Investigation. Early in 1939, the National Resources Planning Board directed its Water Resources Committee to make a thorough-going investigation of the water resources, present water consumption, and future water needs of the Pecos River from its confluence with the Rio Grande in the Big Bend country of Texas to its headwaters in northern New Mexico. Directing that this be a joint inter-departmental project, participants are the Geological Survey, Bureau of Reclamation, Grazing Service, and Biological Survey of the Department of Interior; Office Land Use Coordination, Soil Conservation Service, Forest Service, Bureau of Agricultural Economics, Agricultural Adjustment Administration, Farm Security Administration, and Flood Control Advisory Committee of the Department of Agriculture; and the Weather Bureau of the Department of Commerce. Representative of the Forest Service in Washington is E. N. Munns, and in the field, Regional Forester, Region 3, and Southwestern Station Director.

One extensive field trip over the watershed and a number of meetings of the Committee have been held during the past 18 months, with the chairman and other representatives of the Water Resources Committee participating. The engineer in charge of the project is a representative of the Department of Interior. Agriculture's responsibility involves the history of irrigation development, survey of water-consuming areas, consumptive water use and requirements, drainage in the river valley of the lower basin, watershed management and run-off retardation and soil-erosion prevention, and salinity in irrigated soil of the middle and lower basins. A considerable number of special investigations, mostly by the Soil Conservation Service and the Bureau of Agricultural Economics, are necessary to meet some of the Region's objectives, while most of the information for the watershed management section of the investigation will be taken from the flood survey report of the Pecos watershed. The complete outline of the report has been prepared and approved by field representatives of the participating agencies. The final report itself must be rendered by December 31, 1940, and it is expected that that date can be met.

## FOREST SURVEY

### Appalachian

Inventory. Field work was continued in Virginia throughout the summer, with seven 3-man crews on line. By October 1, approximately 18 million acres (72 percent of the state) were covered. The Coastal Plain and Piedmont units were completed and the work was well advanced in the northern mountain unit. Present plans call for completing the field work in the entire state by January 1, 1941.

The cooperative agreement with the Southern Station has been continued, whereby the field data are recorded on punch cards and tabulated at New Orleans, and by October 1 the master cards, stand table and sample tree cards for the Virginia Coastal Plain unit, had been punched and verified. Volume tables for this unit, based on Girard's field work, were completed and forwarded to the Southern Station for machine tabulating.

The second of the unit reports for North Carolina was issued during June as Forest Survey Release No. 5, "Forest Resources of the Northern Coastal Plain of North Carolina." This unit is one of the best timber-producing areas in the Southern Atlantic States. Its 4 million acres of forest land contain 14.3 billion board feet of saw timber, chiefly second-growth loblolly pine. About 63 percent of the forest area supports sawlog size stands. The total volume in trees 5.0 inches d.b.h. and larger is 73 million cords. The average increment per acre was 163 board feet of saw timber or one-half cord of all sound material.

About 9,000 workers receive direct employment in the 360 wood-using industries in the unit or in supplying them with raw materials. Commodity drain in 1937 amounted to 578 million board feet or 1.3 million cords.

Although the report showed a slight increase in growing stock in the unit for 1937, it points out that forest yields can be greatly increased through better management and improved methods of timber utilization. The favored position of this unit with relation to the great northeastern markets assures a future market for forest products.

California

Vegetation Survey in State-wide Mapping Plan. "Vegetation cover is the sole basis for the lumbering and grazing industries, and bears a significant relation to recreation, flood control, watershed protection, and fire protection...Both sound land use planning and equitable assessment of rural lands depend to a considerable degree on knowledge supplied by vegetation surveys and maps." This excerpt is taken from the California Planning Board report, which recommends completion of state-wide vegetation surveys along with eight other major survey and map series "essential to the proper development of the resources of California". Aerial photographs, and topographic and planimetric maps, all recognized as basic for development of the vegetation survey program, are others in the series recommended for completion under the mapping plan submitted to the Governor of California in February 1940.

Important objectives of the mapping plan as set forth by the planning board are to: "stimulate completion of an orderly survey and mapping program and effect economies in the conduct of surveys and

production of maps". The board strongly urges the formation of a State division of surveys and maps to act as the coordinating agency for all governmental mapping activities in California and to act as a clearing house for the dissemination of information to all map users. In the past there has been an unfortunate variability in standards and duplication of effort in basic mapping programs for the State and thus there is a definite need for the coordination a division of surveys and maps would give. For instance, although about 97 percent of the State has now been covered by topographic surveys only 21 percent of the State is considered to have adequate base maps. The need now is for topographic base maps on a scale of 1" to 1 mile or larger, for nearly 80 percent of the State. Under the plan the details of map making on most major survey projects would continue to be the immediate responsibility of some existing survey agency. Vegetation surveys, for example, are recognized to be a function of the California Forest and Range Experiment Station, and according to the views of the planning board, all future work in that field should be the responsibility of the Experiment Station.

One feature of the plan pertaining to vegetation surveys calls for publication of appropriate bulletins to accompany and explain a group of maps in a unit area. The series of Forest Survey releases in California, of which "Vegetation Types and Forest Conditions of the Santa Cruz Mountains Unit", May 1, 1939, was the first, may well meet this need.

Of particular significance is the portion of the report outlining a financial plan for an initial ten-year mapping program. It provides for cooperative financing of several Federal mapping projects by the State; and in the case of vegetation surveys recommends a state appropriation of $10,000 annually over the ten-year period to facilitate completion of both field and office work on the State-wide vegetation survey. Average annual appropriations requested for other surveys basic to the vegetation mapping program are: $18,500 for aerial photographs; $100,000 for topographic maps; and $9,250 for planimetric maps.

Lake States

The Forest Survey staff is experimenting with preparation of county survey reports for use in connection with county land-use planning. These are based upon data collected in the regional survey supplemented by new field work. Carlton County, Minnesota, is the first county surveyed.

Carlton County, one of the areas selected for unified county planning, is 75 percent woodland, and the potential income from forest work is one of the important factors in farm and community development.

John Macon has been doing the necessary field work, and has been making effective use of AAA air photos and the type maps prepared by the State Conservation Department with WPA help.

Northern Rocky Mountain

Inventory. Mapping and timber estimating is being continued in Missoula, Powell, and Lewis & Clark Counties by a crew of four men. Approximately 1.7 million acres of forest land has been covered by the field inventory during the current field season.

Compilation. The compilation of field data has been completed for Lincoln and Ravalli Counties, is almost completed for Sanders and Mineral Counties, and is well under way in Flathead County. This phase of the work has been completed on approximately 80 percent of the area covered by the field inventory.

Growth. Forest growth calculations have been completed for Lincoln, Sanders, and Ravalli Counties.

Reports. The second draft of the forest survey report for Northern Idaho has been completed and is being prepared for submission to the Washington Office for final editing and approval.

Pacific Northwest

Douglas Fir Region

Keeping Findings Current. The summer's field work is practically complete. Kitsap, Mason, eastern Jefferson, Benton, and Polk Counties have been completed and only about a week's work remains in Wahkiakum County. If weather conditions are favorable one more county will be done.

Office work proceeded slowly during the summer months. Compilations of type areas were completed for western Jefferson, Mason, and Kitsap Counties, but have not been checked, and compilations of saw-timber volume were completed for west Jefferson County. Revised one-inch-to-the-mile type maps for Kitsap and Mason Counties have been traced from the field sheets and after checking will be ready for final inking.

Interpretation and Analysis. The cooperative report, "Forest Resources of Washington", was distributed to an initial Station mailing list of about 400. The State Forester distributed many copies to another list. The revised report for Washington County was mimeographed and distributed. Material for the Clallam County report is

being assembled. The text, tables, and graphs will be processed by the new multigraph-duplicator and hereafter it will only be necessary to have the cover and colored map sent out for multilithing, a considerable saving in time and expense.

The usual run of service jobs continued during the summer and included an analysis of the availability of Sitka spruce supplies for airplane manufacture. Assistance was given by the Regional Office and other Station divisions on this study, but in all it demanded approximately one month's time of the entire Survey staff.

Ponderosa Pine Region

Interpretation and Analysis. "Forest Growth in the Ponderosa Pine Region of Oregon and Washington", a report presenting the results of the growth phase, was multigraphed and distributed.

Manuscript for the regional report was completed and sent to Washington.

Reinventory Results. The most striking fact in the revision of the Clallam County inventory is the ownership distribution of saw-timber volume. The county now has 24.3 billion board feet of which 14.9 billion board feet is publicly owned or managed. The national park has 6.0 billion board feet, national forests 5.4 billion feet, State 1.9 billion feet, Indians 0.8 billion feet, county 0.7 billion feet, and other public 0.1 billion feet. During the period 1933-1939 private saw timber decreased from 12.3 billion feet to 9.4 billion feet due to cutting, and national forest saw timber decreased from 11.5 billion feet to 5.4 billion feet, practically all the result of the creation of the Olympic National Park. Area of State-owned land nearly doubled, increasing from 66 thousand acres to 120 thousand acres, chiefly resulting from the acquisition of cut-over lands via the county foreclosure route.

## NEW PUBLIC DOMAIN

Lake States

Cunningham and Moser accompanied the Minnesota State Land Use Planning Committee on a tour of Marshall, Cass, and Lake of the Woods counties the latter part of August. Eyre and Zehngraff participated in the discussions in Cass County.

In these counties fair agreement has been reached on what areas should be closed to agricultural settlement, and in Lake of the Woods one of the most ambitious resettlement projects in the

county has been concluded. The county committees, however, are just beginning to think about what should be done with the tax-forfeited lands zoned out of agricultural use.

The discussion in all three counties indicated that many on the State committee do not feel that the appropriations needed to give the State or Federal Government clear title to tax-forfeited land, and the tremendous investments involved in reforestation and intensive care by means of CCC or WPA camps, are justifiable. The idea of county or township forests appealed to these men as more practicable.

The county planning work in the Lake States is raising a number of very vital forestry questions and will doubtless have a strong influence upon the research program in forest economics during the next few years.

Pacific Northwest

Rural zoning legislation for Oregon has come to the front in response to the request of the Governor's Economic Council through the Forestry and Lumber Committee of the Portland Chamber of Commerce. In this work the Station was invited to participate. In its report the committee commented upon the application of zoning, including a zoning measure that had been submitted by others for study to forest conditions. It urged that the council encourage study of the subject by farm, suburban, and other rural groups and by public officials who would be charged with its administration to the end that the best thoughts can be brought together before any specific measure is approved or disapproved. Copies of this report may be had on application to the Portland Chamber of Commerce.

Desirable modifications in existing legislation providing for acquisition of tax delinquent and other forest lands by the State of Oregon were worked upon by the Station in cooperation with the State Forester at the request of the Governor's Economic Council and the Forestry and Lumber Committee of the Portland Chamber of Commerce. Under existing legislation, tax-delinquent lands are forfeited to the county in which they lie and not to the State, may be transferred by the county to the State if the county elects and the State is willing, and if so conveyed are held by the State in a custodial capacity for the county in which they lie rather than in a proprietary capacity for all the people of the State. Transfer does not discharge tax equities existing at forfeiture, hence the taxing process is incomplete. The State now has no authority to acquire lands for State forest purposes by purchase of gift, nor may it consummate any exchanges with any agency without consent of the county or counties in which the exchange lands lie. In approaching desirable modifications the attempt has been to authorize and facilitate

acquisition by purchase and gift, remove unnecessary restrictions on exchange, and permit the State to settle tax equities in tax-forfeited lands at or subsequent to transfer from county to State. Provisions for classification of tax-forfeited lands and prompt organization into public forests of all those classified as best suited for public use or ownership have been considered but the general feeling is that they would not be supported until considerable educational work was conducted in this direction. The principal difficulties in securing adequate acquisition legislation lie in (1) a wish that broad areas of deforested lands would be converted into pastures for private use and ownership, (2) a confusion over responsibilities of the sovereign government -- the State, and (3) a lack of knowledge of what the State now contributes to local government. The need for information about State contributions may be met as a result of a conference between State Budget Director Eccles, State Forester Rogers, Assistant Regional Forester Andrews, and Wilson of this Station.

Land Planning. In connection with county agricultural planning in forest counties, in which Wilson was engaged for days on end during the 4-month period, the following become more and more evident:

1. Unified programs should be conducted on a broad plane and not on a narrow one.

2. Reports on unified county studies should be objective, not subjective -- they should not be directed against forestry in order to promote grazing of forest lands.

3. Long-term economic predictions as to land use should be based upon physical, biotic, and economic criteria, otherwise they are sheer guess work -- local satisfactions and dissatisfactions are clues to order and disorder but are unreliable measuring sticks of themselves.

4. No competent analysis of some subjects, such as institutional factors in land use adjustments, can be made from less than a State-wide or regional approach -- such subjects should not be included in unified county or other county reports without prior benefit of State-wide or regional treatment.

5. No competent analysis of some subjects, such as peculiar forest management problems, can be made without benefit of intensive case studies -- to come to general conclusions from peculiar situations superficially investigated is tempting but futile and often disastrous.

6. Formulation and solution of general forest problems have a place in agricultural planning reports for forest counties when handled by specialists in forestry.

7. Cooperative researches coordinated under proper settings appear in order.

Wilson, among other things, partook in work of a special advisory committee appointed to consider tax delinquency problems in Coos County, Oregon; cooperated with Oregon State officials on a State forest policy and a State conservation program; reviewed and commented upon several Station and other manuscripts; progressed with his New Public Domain report; and brought his progress report on Washington's tax collection and related laws close to the point of publication.

Taxation. The subject of school district reorganization and its relation to forestry and land use in the State of Washington was presented by DeVries in a paper read before the School finance Section of the Institute of Government at the University of Washington in July. There is a great deal of interest on the part of the State Board of Education Committee on School District Reorganization Survey in the Maine unorganized territory system of school administration and finance. This committee is now committed to a plan for State-financed and administered services in isolated and remote areas. DeVries was able to point out the probable effect of such a plan in stabilizing and removing some of the uncertainties of property taxes, and the importance of this in making a long-term enterprise such as forestry economically feasible. The possibilities which such a plan offered in equalizing educational opportunities was also emphasized.

The study of 1940 property tax rates in Oregon and Washington is being put in the form of a Station publication. Due to the lack of uniform methods of accounting and reporting, it is impossible to make a direct comparison between counties of the tax rates for the various units of local government. For example, in Washington the tax levy to pay delinquent State taxes of former years may or may not be included in computing the current county tax rate. If the statutory county tax rate limitation is being approached or exceeded, the extra levy for the delinquent State tax will be included in the State tax rate. Otherwise, such as when the county is not pressed to keep within its rate limitation, the county rate will be made large enough to produce enough to pay delinquent State taxes.

Some attempt was made at analyzing the distribution of tax rates in the two States. With several counties having as many as 150 tax rates in effect in the different parts of their rural area, the median total tax rate for each county was computed. The median rate for each county in Oregon and in Washington was placed in order of magnitude and a median rate for Oregon and for Washington was computed. It is very interesting, although of doubtful significance, that the State median thus computed was 27.5 mills for Oregon, and 27.5 mills for Washington also. This is the rate as applied to assessed value; differences in assessment ratio were disregarded in the computation. The variation in total tax rates among the districts of a county is

usually much greater in Oregon than in Washington. The variation in median tax rates among counties is also much greater, about twice as great in Oregon as in Washington. Equalization funds in Oregon are much less in amount and in effectiveness than in Washington.

The manuscripts prepared by the Regional Office describing the data and computations used in estimating the probable property tax load on controverted lands in the Northern Pacific case were reviewed. Several reviews were also made of manuscripts prepared or used by other divisions in the Station where they contained references to forest taxation.

## FOREST TAXATION AND INSURANCE

### Southern

A supplemental progress report from Craig's tax-index project in Mississippi was issued June 5 -- "Taxes on forest property in two selected counties in Mississippi, 1936-1939, with State averages" /Southern Forest Experiment Station Occasional Paper No. 89 (Supplement)/. The State averages were based on seven counties (Alcorn, George, Holmes, Marion, Newton, Quitman, and Webster) and showed the average assessed values and average ad volorem taxes per acre on forest property for the years indicated, with annual indexes based on the period 1936-1938 as 100. The issuance of this report completed initial work in Mississippi.

Field work in Alabama was begun in June, after conference with State officials on procedure and selection of counties. Counties chosen were Barbour (shortleaf-loblolly pine type, southeast Alabama), Blount (same type, but in mountains of north central Alabama), Butler (samo type, south central), Colbert (shortleaf pine and bottomland hardwood types, northwest), Coosa (upland longleaf pine type, central), Escambia (longleaf-slash pine type, southwest), and Tuscaloosa (shortleaf-loblolly pine type, west central). Data are being taken on values and taxes for 1937-1940 inclusive, and the index-base will be the period 1937-1939 as 100.

Field work has been completed in Escambia and Butler counties. It will be resumed in Colbert and Blount counties in October.

Because of assessment methods in Alabama, determination of average assessed values on forest land per se is extremely difficult, and in some cases impossible. All rural land owned by a given taxpayer in a county is assessed at one blanket value, in which may be included values of several separate tracts, in various uses, locations, and conditions. This is particularly true of farm properties, but even in the case of lumber company holdings it is not uncommon to find a single blanket assessment for all land and standing timber held by the company in the given county. Such assessment practice makes separation of values by forest types and condition classes

very difficult, but in the first two Alabama counties covered it has been possible to derive such values and the related taxes by careful selection of peroperties and by recourse to private corporate tax records. Whether accurate data can be obtained in counties characterized chiefly by farm forest properties (i.e., where all or most of the forest land is held as parts of farms, and included in one blanket assessment with crop and pasture land) is subject to considerable question. For this reason Barbour County, where this condition obtains, may be omitted from the study and another, as yet unselected, county substituted.

## PRIVATE FORESTRY

### Central States

Farm Woodlands. During the summer, work was continued upon the analysis and preparation of tables for the Illinois farm woodland study.

The tables of stand structure, growth, log and tree quality, and others relating to forest production are practically complete. Typing of these is in progress.

Work has begun on relation of forage production to forest growth in woodlands of different densities for evaluating the contribution of each to income. The data on pastures, farm structures, and wood consumption are now being computed.

### Northeastern

Cooperstown Cooperative. In order to simplify procedure in the handling of the Government loan to the Otsego Forest Products Cooperative Association, the Farm Security Administration has asked to be relieved of its share of administrative responsibility. Accordingly, early in September the Secretary of Agriculture gave full responsibility for the Otsego loan to the Forest Service. In order to deal more effectively with the many complex operating problems with which the Association must deal during the coming months when it will be developing volume for its first full operating season, the Forest Service has detailed H. Phil Brandner to Cooperstown as loan administrator. For the past two years Brandner has been with the New England Forest Emergency Project as State Director of timber salvage and fire hazard reduction work in New Hampshire.

During the summer the association has conducted an intensive membership drive which by October 5 had raised the number of members to 561. Enlisting members during the summer season when farmers are busy with their crops and not ready to think about woods work, required an average of about 6 hours of field time including travel. The association has inaugurated a monthly news organ called "The Otsego Forest Cooperator", which has aroused much favorable comment and should prove an effective means of member education.

Fall logging operations got under way late in September. With a goal of at least 3,000,000 board feet for the entire season, contracts for delivery of about 1/2 million had been signed up by October 5. It has been found that only about one-third of the members expect to do all their own work in the woods, and that more than one-third will have the entire job hired. This reduces the cash value of the cooperative service to members and makes it more difficult to obtain active interest. It also increases the burden on the association in arranging crews to do the work for the members. Labor skilled in woods work is not easy to find in this agricultural community. To get out the desired volume of production it may be necessary to import some labor. The cost of clearing logging contracts with members, arranging to get work done for them, and inspecting results all bring pressure upon the association to increase the intensity of cut in order to get a larger yield per farm in the initial operation. This usually implies a lengthening of the cutting cycle, which in turn may create a problem of continuity of member interest.

Based on analyses of growing stock on the 8,000 acres of woodland which have been tallied and marked, a standard of 2,500 cubic feet per acre has been tentatively set up as an ideal. Relatively heavy initial cutting is indicated when the growing stock present is in excess of this figure. However, except in very unusual cases, marking for the initial cut is never allowed to exceed 35 percent of total cubic foot volume.

While production of small-dimension stock has continued throughout the summer, the sawmill proper started the season's operation early in October with production from the 42" bandsaw at about 14,000 board feet per day. The bolt saw should bring total production up to 18,000 per day of eight hours. Markets for the products are active. There exists a strong demand for hardwood dimension stock, especially sugar maple. Outlets for beech are also satisfactory. In fact, the association has not had enough available to fill some of its orders during the summer. Local sales of softwood have been developing as anticipated. About $1,000 worth of lumber was sold back to farmer members during the month of September.

Farm Forestry - Connecticut. Tests of an 80-h.p. boiler at the Niantic State Farm for Women, using coal as fuel, are now

completed. Due to failure of the contractor to fulfill his obligations in the installation of hogged wood conveying and stoking equipment, it has not been possible to make the proposed tests of hogged wood for fuel. New plans for equipment are now nearly complete and it is expected that this part of the project will again be ready for tests.

As a result of the impossibility of completing the boiler tests with wood, the cost studies of hogging and transporting wood have been delayed. Plans, equipment, and material are ready and this part of the project will go forward with the installation of wood-burning equipment at Niantic.

A progress report of tests of ten Char-Wood Heaters has been finished. The tests indicate that the heater performs satisfactorily in producing uniform heat, in convenience of operation, and economy of fuel. The unsatisfactory feature of allowing smoke and ash to escape to the room when firing has yet to be corrected. The tests have resulted in some improvements in design and appearance of the heater.

Time studies are under way on the Cockaponset State Forest, testing tools and equipment for fuelwood production. Work has been finished with hand tools. Skidding, bucking, and splitting are now under observation, using power tools and equipment of new design. Indications are that some savings in time can be expected by using equipment designed to eliminate much handling by yarding and hauling wood in bundles of a cord in size.

An experimental charcoal kiln is in operation and eight charges have been burned. Very satisfactory results have been obtained both in quantity of charcoal produced and in the attendance time required. Between 40 and 45 bu. of charcoal per cord of wood have been produced. A portable kiln, rectangular in shape, is now under construction as a result of the information obtained from the experimental kiln in regard to draft arrangement and control and coaling temperatures.

A report has been prepared covering the investigation of the use of producer gas generated from wood for institutional heating and electrical power. It was found that due to high peak loads, the size of the plant required would necessitate the delivery of wood to the particular institution used as a sample at a price of $4.20 per cord. This price is based on the present cost of coal at the same institution. Such a low delivered price cannot be met under present economic conditions.

Southern

Swarthout and Bruce's report on the first study under the Norris-Doxey Farm Forestry Research Project in Alabama, covering

a survey of factors affecting pine reproduction in Tallapoosa County, was completed in August and distributed to State Forester Toler, the Alabama State Agricultural Experiment Station, and the Washington Office.

Tallapoosa County, Alabama, has about 21 townships in the Piedmont Soil Province and about 3 in the Lower Coastal Plain. The prevailing forest type is shortleaf-loblolly-hardwoods. In the spring of 1940, 115 plots were selected at random from the woodlands within the county, at the rate of 4 or 5 plots per township, and usually 2 miles or more apart, and systemtically described from the standpoint of all factors likely to affect natural reproduction of loblolly, shortleaf, and longleaf pines.

An analysis of the data showed that chances of obtaining satisfactory natural reproduction of pine are best where there are: (a) 3 or more good (5 or more fair) seed trees per acre; (b) fair to good seed production following the opening of the stand; (c) practically complete exclusion of fire and grazing while the new stand is young; (d) a pine crown density of 40 percent or less; (e) a hardwood crown density of 15 percent or less; and (f) 20 percent or less of the ground occupied by understory competition to the exclusion of pine. An unfavorable alteration of any one of these factors may reduce or prevent pine reproduction.

It was found that approximately 70 percent of the stands studied that were old enough and cut over severely enough to require reproduction had failed to reproduce satisfactorily to pine.

Field work, computations, and the rough draft of a report have been completed for a similar study on different geological formations and soils in Autauga County.

Farm Woodland Studies. During the summer Bond directed the computing and analysis of the field data taken in Hempstead County, Arkansas. He also supervised the field work for a second study in Washington Parish, Louisiana. This study is also being made as a part of the Bureau of Agricultural Economics-State Agricultural Station farm management project. On the forestry phases of the study the Soil Conservation Service furnished R. R. Rhodes, Junior Forester, to collect the field data and the Southern Forest Experiment Station supervised the field work and is now computing and analyzing these data.

Although Washington Parish is generally considered as a longleaf pine parish, most of the farm woodlands contain loblolly pine and hardwoods. These woodlands usually occur along branches or larger streams on sites that are too wet or steep for cultivation of crops. Most of the uplands, which were forested with longleaf, have been cleared and cultivated. Farms usually contain less than 40 acres with about half of the total in farm woodlands. The requirements for fuel, fence posts, and other forest material on the

farms and for cash sales have severely depleted the merchantable timber. Markets are available for logs, pulpwood, ties, poles, and posts, and with rapid growth of good species the possibilities of the woodland supplementing the income from farm crops is promising, provided more conservative methods of cutting and management are adopted.

## FOREST MANAGEMENT RESEARCH

### FOREST FIRE PROTECTION

Appalachian

Effect of Basal Wounding on Growth. Jemison has made a detailed field survey of the effect of basal wounding by fire on the rate of diameter growth. Yellow poplar, white oak, and scarlet oak on several different burns were measured. Scarlet oak, the species most susceptible to fire injury, showed a slight reduction in growth rate when wounded, but all other species were unaffected. The apparent explanation lies in the rapid reorientation of conducting tissue in the vicinity of fire wounds. In many cases, trees wounded through 90 percent of their circumferences continue to grow as rapidly as before, but the wood tissues are often laid down at right angles to their former direction. Thus, conduction paths from the roots below these large wounds are not destroyed.

Foliage and root samples on the wounded and unwounded sides of trees have been collected for laboratory analysis by Jemison at Duke University this winter.

Experiments with "Frost Pockets". By placing fuel moisture indicator sticks in a miniature "frost pocket", Byram has found that their moisture content may overnight go as high as 60 or 70 percent, while sticks not more than 3 feet away, but outside the frost pocket or radiator, did not have moisture contents greater than 15 percent. The device consists of an open-top box with insulated sides and bottom, the inside of the box lined with polished sheet aluminum or copper. Objects such as wood sticks placed in the box on a clear night radiate their heat into space more rapidly than they can gain heat by radiation and conduction from their surroundings, hence suffer a loss in temperature. When their temperature falls below the temperature of the dewpoint, moisture condenses on the sticks and greatly increases their weight.

A thermometer placed in the box sometimes gave a reading 12 degrees or more below air temperature. This means that a pan

of shallow water should freeze in the frost pocket even when the air temperature is as high as 44 degrees F.

The cooling phenomenon just described is well known to meteorologists, but the importance of its influence on a large scale on forest fuel moisture in certain locations has probably not been fully recognized. The cooling is caused by terrestrial radiation, but does not take place on cloudy nights because a cloudy sky is opaque to these long wave-length radiations.

California.

The study of southern California fire statistics in collaboration with the Regional Forester's Office described in the June report (p. 17) was completed in June with the preparation of a manuscript under joint authorship of Regional Office and Experiment Station personnel. The results of this work will be used in conjunction with those to be derived from further study of other phases of fire history of the South in the development of a fire research program for southern California. In the meantime advantage has been taken of the current field season to initiate the attack upon some of the recognized outstanding fire control problems.

Abell and Bruce have been conducting a detection study on the Angeles Forest to determine the adequacy of the present system. Fire statistics indicate that the Forest Service lookout system is responsible for only 15 percent of the first discoveries on the Angeles Forest. To determine the causes of this low percentage and to obtain a field check upon the efficiency with which the remaining 85 percent are reported are the immediate objectives.

During the current season Abell is also making a study of southern California large fire patterns to determine the behavior of past fires in relation to weather, topography, and fuel types. Much additional information is needed on these relationships to provide an equitable basis upon which to evaluate existing and proposed fire breaks, and to provide for further development of fire suppression strategy on the southern forests. Large going fires are studied currently to obtain additional information on patterns as well as information upon rates of spread and other behavior phenomena.

In addition to his participation in the Angeles detection study, Bruce is making field examinations of soil sterilization and stump-killing projects in southern California and in the Sierra region. No further treatments other than a limited number of demonstration areas were planned for the current season.

The studies of water and chemicals for fire suppression use initiated by Bruce during the spring months will be resumed during the coming winter. Several months will be required to complete the laboratory stages of the work.

The fire behavior project under Buck, Fons, and Stromberg has been primarily concerned during the current season with continued study of the individual variables influencing rate of spread. Additional data on weather and fuel moisture relationships are being secured, and the fuel study has been expanded to include other kinds of fuel in addition to the needle litter beds employed in the past.

Early in the season 10 standard 3-cup anemometers were secured on loan from the Prairie States Forestry Project. These and our own were installed with recording equipment at a number of different sites and exposures to provide additional information on the relationship of wind movement to height above ground and character of the ground cover. The data being secured in this study will be of particular value in connection with the proposed revision of the Region 5 fire danger rating system during the approaching winter. They should also prove of value in the final selection of a national standard anemometer exposure for fire danger rating purposes -- recognized as one of the first steps which must be taken to secure national harmonization of fire danger measurements.

Incidental to the daily weather observations at Pilgrim Creek Nursery, records have been maintained of the 8, 12, and 4:30 performance of a series of 40 moisture indicator sticks as a final check upon R-5 manufacturing and testing methods. The series includes sticks which have been selected for their uniformity of behavior in the testing cabinet as well as those which deviated to varying degree. There are also included in the series 10 sticks treated with wood preservative. Untreated sticks in current use lose from 1 to 2 percent of their original dry weight in a 4- to 5-month season of exposure, thus precluding the possibility of their use a second year by organizations employing the R-6 type of moisture stick scale. If the preservative will prevent this loss in weight without altering the stick response to weather changes, the way may be paved for production of sticks which may be used a second season.

The preliminary work on fire ignition undertaken by Blanchard last year has been continued during the current season with further development of the experimental technics. Incidental to this development, some data have been secured on the probability of ignition of rotten wood by cigarettes under varying conditions of wind, temperature, humidity, and fuel moisture content. There is not yet sufficient data to justify conclusions.

Withdrawal of the Experiment Station group from the large fire suppression organization of the Shasta Forest has permitted utilization of the time formerly devoted to fire suppression activities to the study of large fire behavior. Although the unusually favorable fire season limited the opportunity for much study on

the Shasta, three fires were visited during July and August. Excellent cooperation in the form of early information on the existence of potentially large fires was obtained from the Central Dispatcher's Office.

Upon his return from M. I. T., Blanchard was detailed to the Mt. Shasta Office of the Weather Bureau to continue under field conditions the cooperative study of thunderstorm forecasting. The almost total absence of thunderstorm conditions in the northern California area, together with curtailed radiosonde observations during part of the period, limited to a critical extent opportunity to check the forecasting methods employed. The project is to be continued at M. I. T. for another school year.

Both the northern and southern California projects will be terminated at the end of October. Upon return to Berkeley the group will undertake the scheduled regional fire control problem analysis.

Lake States

A field study of the effect of cover on inflammability of fuels was completed at Eagle River, Wisconsin. The method used was to study the rate of drying and the moisture content of the fuels under different cover and atmospheric conditions. Duff hygrometers and sticks were used to secure the basic measurements. The covers studied were mature hardwood-hemlock, sapling aspen, cut-over hardwoods, and a control station in the open.

Additional data on the rate of spread of fires were added to those already collected in previous years, and a multiple regression of the rate of spread on danger rating and wind velocity was calculated. The data used were collected on over 3,000 fires in all three of the Lake States. The basic purpose of the study is the classification of fuel types for the preparation of dispatching tables.

Northern Rocky Mountain

Although the 1940 fire season with its 3,500 fires is being characterized by the Region 1 administrative organization as "Streptococeyed if there ever was one," from a research viewpoint it was one of the best yet. In other words, their poison is our meat.

Rating the character of the 1940 season apparently is going to require a new definition of what is meant by "critical", because when a generally recognized Constant suddenly becomes a major Variable, old formulae usually won't work. With 3,000 lightning fires this year, instead of the previous relatively constand load of from 800

to 1,200, it is obvious that if fires would burn at all, and THEY DID, the fire control organization had to meet a truly critical situation. On the other hand, this same result could be obtained any year by merely doubling the area protected by the regular organization and thereby doubling the normal number of fires to be handled. But doubling the area protected would not mean that that season was any worse than the one before.

This brings sharply into focus a feature that has been rather fuzzy, to say the least, in our past ratings. If fire control would only use practicable, significant classifications of fires like "Step Outs" or "Mae Wests", instead of such highly artificial, non-significant classes as A, B, C, etc., the problem of rating the 1940 season would not be so difficult. If we knew, for example, the percentage of fires which "send up an attractive curl of smoke definitely inviting you to come up some time -- most any time -- and then lie down and wait for you to come and get it," the problem of separating difficulty-of-control from number-to-control would be much simpler.

To aid the Northern Rocky Mountain Station in attacking its more difficult problems of fire behavior and rate of spread, Stickel was transferred from the Northeastern Station in mid-July. Stickel will head a project which has been financed since June 1939 by the Regional Office, with previous field work being done by C. K. Lyman alone. With double the usual number of fires occurring in the region, Lyman was able to obtain 33 measured samples of rate of spread and 51 samples of rate of line construction on 10 different fires. Stickel arrived in time to get in on two of these fires, including one burning in dense green timber with a measured relative humidity of only 12 percent beneath the timber. Samples included the Low, Medium, and High rate-of-spread and resistance-to-control types. Fall work, on fires to be set in the Extreme-Extreme type, in the course of the Region's hazard reduction program, will extend the data to include all Region 1 fuel types.

Galley proof was received in September for Hayes's circular U.S.D.A. No. 521, "Influence of Altitude and Aspect on Daily Variations in Factors of Forest Fire Danger". This publication summarizes the results of four seasons' research on one ridge, from 2,300 to 5,500 feet elevation, at Priest River. The outstanding discovery was the presence of a thermal belt at mid-elevations within which, at night, temperatures were higher, relative humidity and fuel moisture lower, and fire behavior materially more dangerous than either above or below the belt.

During the past three months, Hayes and Cline, with $4,000 worth of recording instruments packed carefully into an oversize station wagon, visited three widely separated portions of Region 1 to test the Priest River altitude and aspect findings under other ranges of altitude. In the Salmon River Canyon on the Nezperce Forest measurements were made up a south-facing ridge extending from

1,850 feet to 7,700 feet elevation. On the north face of Desert Mountain on the Flathead Forest six stations, five of which had to be packed in and out by hand, were operated to sample conditions from 3,250 to 6,400 feet elevation. Last, along the highly scenic Red Lodge-Cooke City road on the Beartooth Division of the Custer Forest data were obtained on a northwest aspect for the steepest type of topography extending to the highest altitude, 7,400 to 10,500 feet, to be found in this region.

By these three tests the data have been carried from the Transitional through the Canadian, Hudsonian, and on into the definitely Artic-Alpine zone of plant life; from far below the lowest to well above the highest timberline. Preliminary inspection indicates that the altitudinal characteristics found at Priest River hold true in principle throughout this great range. The thermal belt was found more poorly developed, however, at the lowest and highest elevations. On Desert Mountain, typical of a majority of our area, the belt was markedly similar to that found at Priest River. Several "freak" spots, shown as peculiar by several years of fire danger measurement, still remain to be studied but due to personnel decreases that may be essential next year, further tests are unlikely in the near future.

Pacific Northwest

Study of Adequate Fire Control on Private Lands. While the report on the first sample area, western Snohomish County, Washington, was being reviewed and prepared for processing as a Station publication, Matthews and Morris started on the second sample area, the Clackamas-Marion unit in Oregon. This area was selected for study after consulting with members of the Advisory Council and other interested persons. It contains a wide variety of ownerships besides private lands, and its cover and fuel conditions are typical of the forest lands bordering the Willamette Valley. It has been subjected to a fairly constant level of fire-control effort for several years. An analysis will be made of present fire control, including results and costs, in order to develop a plan for adequate fire control with estimates of costs.

Climatic Hazard in Slash After Partial Cutting. The slash hazard is one of the greatest objections to partial cutting in the Douglas-fir type of Region 6. Disposing of this hazard is difficult because piling is too costly and the mortality of reserve trees is liable to be great with a broadcast burn. Fire weather as it affects this selective cutting slash is a major part of the hazard and may determine whether accidental fires can be suppressed or when disposal fires should be set. To study the weather in selectively cut stands 4 weather stations were operated during the past summer on the Westfir sale of the Willamette National Forest in cooperation with

the local forest officer. The following forest cover conditions were sampled: clear cut, heavy selection cutting with about 80 percent gross volume removal, light selection cutting with about 35 percent gross volume removal, and virgin timber. Leonard Blodgett made daily observations at each station of fuel moisture indicator sticks, standard Weather Bureau wind gage, and hygrothermograph. A preliminary inspection of the records shows that the virgin timber fuel sticks read higher on dry days than those at the other stations by the following amounts: light cut 1½ percent, heavy cut 3 percent, clear cut 4 percent. On such days the sticks on the clear-cut area read about 7 but occasionally fell to 6 or less. The difference between the virgin timber relative humidity and that at the drier stations on dry days was as follows: light cut 0-5 percent, heavy cut 5-12 percent, clear cut 5-12 percent. The total daily wind movement in the clear-cut area was about 3 times that in the heavily cut area, 4½ times that in the lightly cut area, and 6 times that in the virgin timber.

## Southern

### Effects

Effect of Fire on Radial Growth of Longleaf Pine. A progress report has been prepared on a study of the effects of fire on the radial growth of longleaf pine. This was primarily a study of increment cores taken at B.H. from areas that were burned two to six years previously in comparison with cores from areas that were unburned at that time -- the observations were paired as to site, general size, density, etc., as well as conditions would permit.

The average effect appears to be a loss of growth up to about 60 percent as a maximum for the growing season immediately following the fire, usually followed by a loss of 10 percent or less during the second growing season, with no loss or perhaps a slight gain thereafter. The responses of individual trees showed considerable variation; in general, the trees whose crowns were closest to the ground (and to the fire) were most sensitive, while those with high crowns and moderate to slow growth rates were most complacent. The most vigorous trees were the ones most likely to show apparent stimulation in the second to fifth growing seasons.

Two trees were sectioned at intervals of 4 feet, starting at B.H. These sections show a fairly high degree of circuit uniformity -- although without a microscope some rings appear to be only locally present -- whereas the effect diminishes progressively from breast height to the tip.

Identification of rings from areas that have been severely burned is difficult without considerable magnification. It was

found in this work that the two narrow rings of 1924 and 1925 in central Louisiana due to drought and the "frost ring" of 1932 in southern Mississippi were valuable points of reference in ring identification.

Effect of Fire on the Regeneration of Shortleaf and Loblolly Pine. A study of the possible use of fire as an aid to pine regeneration in the shortleaf-loblolly pine-hardwoods type has been undertaken on the Crossett Experimental Forest. Burning may permit more seed to reach mineral soil, reduce the intensity of competition from hardwoods and deciduous shrubs, and increase the available nutrients. On the other side of the picture, there is no question that pine seedlings of these species will be killed, if present, and that there may be some loss in growth and some basal wounding. The burning must be done in advance of seedfall on areas where present stocking of seedlings is unsatisfactory. Since the method of management is selective cutting, the wounded trees can be removed virtually as soon as the injury becomes apparent. Any losses that may occur in radial growth are, in effect, an expense that can be legitimately charged against this method of securing pine regeneration. The alternative has been alleged to be "worthless hardwood brush".

## FOREST GENETICS

### California

The work on identification of young seedlings by gross characters and by stomatal differences is becoming increasingly important in the segregation of hybrids as this is the only method by which seedbed selection may be made. The difficulties encountered may necessitate a change of basic practice in the case of hybrids. Primary needles of pine species are very conservative and show few diagnostic differences. The early secondary needles begin to develop reliable characters but it seems doubtful, after comparing the needles of seedlings with those of mature trees, whether this method can be applied with confidence to seedlings less than three years old. These findings may make it necessary to use 3-0 stock or 2-1 stock to insure the selection of valid hybrid plants for out-planting.

The first stage of grafting experiments conducted by Mirov has been completed. An article entitled "Tested Methods of Grafting Pines" was sent to the Journal of Forestry for publication. Experiments in grafting, with the purpose of inducing early flowering in pines, have been continued. It is of interest to report

successful grafting of scions taken from two-year-old ponderosa pine transplants on an overmature ponderosa pine.

A research note, No. 21, entitled "Additional Data on Collecting and Propagating Seeds of California Wild Plants", (17 pages) was published August 1. A second printing of the note was made in September, chiefly to satisfy requests of the University Extension Service for additional copies of this publication.

In an attempt to throw more light on the influence of seed size on seedling development, a test was started by Austin two years ago with ponderosa pine. Preliminary analyses are now available covering two years' development.

Seed from 29 seed-trees of ponderosa pine, growing at various elevations in El Dorado County, was graded with a Clipper seed-cleaning machine. Results will be presented that were secured with the progeny from one of the 29 trees.

Large quantities of seed were necessary in order to secure enough seeds of the extreme upper and lower grades.

| Through screen size | No. of seeds available | Seeds per C.C. |
|---|---|---|
| 10 | 454 | 18.2 |
| 11 | 4,701 | 16.6 |
| 12 | 13,318 | 14.3 |
| 13 | 6,000 | 12.5 |
| 14 | 233 | 11.1 |

Since the middle one of the three dimensions of a seed determines which screen it will pass through, seed size is better expressed by the number of seeds per cubic centimeter.

Measurements were taken at several periods to determine whether seed size shows its effect chiefly on initial and very early seedling size, and if this effect is still pronounced at the end of the two-year nursery period. The results conform closely to those of previous workers.

The chief points of interest can be seen in the following table based on the average behavior at all four nurseries. The first item refers to the length of the hypocotyl or stem below the cotyledons, the other items refer to the heights above the cotyledons.

| Seeds per C. C. | Average heights in feet | | | | | |
|---|---|---|---|---|---|---|
| | Hypocotyl | 75 days | 75 days to 1 yr. | 1 yr. | 1 yr. to 2 yr. | 2 yr. |
| 18.2 | .049 | .055 | .079 | .134 | .366 | .500 |
| 16.6 | .050 | .067 | .085 | .152 | .374 | .526 |
| 14.3 | .052 | .070 | .101 | .171 | .438 | .609 |
| 12.5 | .058 | .079 | .104 | .183 | .454 | .637 |
| 11.1 | .060 | .079 | .123 | .202 | .463 | .665 |
| Dif. between grades 11 & 18 | .011 | .024 | .044 | .068 | .097 | .165 |
| Dif. in percent of average | 20.4 % | 34.3 % | 44.9 % | 40.5 % | 23.2 % | 28.1% |

It is interesting to note that large differences in seed sizes had but a relatively small effect on the height of the hypocotyls. It is also evident that seed size exerts an influence not only during the juvenile stages, but throughout the two-year nursery period. Hence, regardless of subsequent development, the grading of ponderosa pine seed has a practical value in forest nursery practice.

It will be observed that growth made during the second half of the first year (namely, that labelled "75 days to 1 yr.") has the greatest percentage difference, and that the percentages are smaller at both earlier and later periods.

Lake States

Experience the last few years in planting hybrid poplars has raised questions as to the nutrient requirements of these trees. When planted in the nursery where fertility is high, they make spectacular growth. When planted in the field on sandy soils in furrows or on blow sand where plant competition is low but where moisture supply is good, the growth has been very poor. This past season a special test was laid out at the Manistee arboretum. Cuttings were planted (1) in regular planting furrows, (2) in completely spaded up scalps 3 feet in diameter, and (3) in ground completely spaded up, as in a garden. Growth in the first is the poorest (about 1 foot); in the second it is better (1.5 to 2 feet); and in the third it is best (3 feet or better), which is about the same as cuttings planted in the nursery. Possibly the cultivation has released nutrients needed for growth of the hybrids.

Northeastern

Breeding with Acer. The results of the 1940 breeding work on Acer are now available. (Seed collection on other genera has not been completed.) The use of Visking bags greatly facilitated breeding with maple species. Pliofilm bags tried on white maple practically fell apart within two weeks. The extensive losses resulting from the use of pliofilm bags on the early-blooming Acer saccharinum are reflected in the following table which lists the number of seeds obtained from the indicated controlled pollinations.

Acer saccharinum (♀)

| | | |
|---|---|---|
| Self-pollination | -- 17 | seeds |
| Intra-specific cross-pollination | -- 5 | " |
| Inter-specific cross-pollination | | |
| X A. rubrum (♂) | -- 118 | " |

Acer rubrum (♀)

| | | |
|---|---|---|
| Intra-specific cross-pollination | --1912 | " |
| Inter-specific cross-pollination | | |
| X A. saccharinum (♂) | --1021 | " |
| X A. palmatum (♂) | -- 1 | " |
| X A. campestre (♂) | -- 1 | " |

Acer saccharum (♀)

| | | |
|---|---|---|
| Self-pollination | -- 464 | " |
| Intra-specific cross-pollination | -- 188 | " |
| Inter-specific cross-pollination | | |
| X A. saccharinum (♂) | -- 215 | " |
| X A. rubrum (♂) | -- 234 | " |
| X A. cappadocicum (♂) | -- 83 | " |
| X A. palmatum (♂) | -- 109 | " |

Acer saccharinum and A. rubrum mature their seed in late spring. Germination of control-pollinated seed of these two species was excellent.

It should be noted that intra-specific cross-pollinations are not extensive on a single ♀ parent. Such crosses, in limited numbers, are useful as a check on breeding technique, and it is expected that the intra-specific progenies will be of value as "yardsticks" for evaluating hybrid progenies. A comparison of intra-specific progenies and seedlings derived from open-pollinated seed collected from the same parent tree will also be useful in determining the possibilities of the "one-parent" progeny test.

Pollen Technique. Pollen germination techniques have been worked out to a sufficient degree of reliability to permit rapid

routine viability determinations of all pollen samples following their use in controlled breeding. The results of pine pollen storage experiments, which indicate optimum conditions for Pinus strobus and P. resinosa as 50 percent relative humidity and 4° C. have aided in the development of better storage methods for pollens of hardwood species. Further work in this field is needed and gives promise of worth-while results.

Cytology. Preliminary results of a study of apomixis in birch indicate that in bagged, non-pollinated catkins of Betula papyrifera about 1 percent of the nuts have fully developed embryos. Cytological studies of young ovaries from non-pollinated catkins now under way on B. papyrifera and B. lutea should yield information on the exact type of apomixis. Knowledge of the frequency and nature of apomixis is fundamental to the interpretation of results of controlled breeding work.

## MENSURATION

### California

A recently completed study dealing with the estimation of vegation-type areas by linear measurement indicates that this method has several important advantages over mapping. Compared to mapping as a method of determining areas, it is easier and cheaper to apply, provides more useful information because more detail can be recorded and sampling error can be calculated, and is comparatively free from bias due to personal factors.

The vegetation types used in the study included reproduction, brush, bearmat, and open. The maps of 3 plots totaling 31.2 acres in the mixed-conifer timber type in the Stanislaus National Forest were used as the basis. These plots were mapped before logging, immediately following logging, and again 5 years later.

Parallel lines scaled 3.3 feet apart were drawn on the maps and the distances scaled through each vegetation type. When these distances were converted to area by multiplying by 3.3, it was found that the areas obtained checked closely with the areas as planimetered. By analysis of variance it was found that lines 12 chains in length were more efficient sampling units than either 4-chain or 2-chain lines, and that random-within-block sampling, using 1 by 12-chain or 1/2 by 12-chain blocks, was better than unrestricted random sampling.

Each plot was 12 chains in length. By subdividing the 31.2 areas into 26, 1 by 12-chain blocks and taking two 12-chain lines

at random in each block, the range of error for 19 in 20 trials was within 7 percent of the true area of each type. By doubling the number of lines and reducing block size to 1/2 by 12 chains, the sampling error dropped to 3½ percent. Even with the latter intensity of sampling the saving of time as compared to mapping is known to be considerable.

By staking the sample lines at the first measurement, periodic remeasurements provide close to the true measure of changes along these lines. When converted to area these estimated changes based on linear measurements differ from the true changes by sampling error alone, and this can be evaluated. Since lines differ initially in distances through types, the lines were equalized in this respect by covariance analysis, thereby reducing the standard error of the estimated change in type area. The absolute amount of change was found to have no significant relation to the magnitude of the standard errors so determined. This finding is of importance in planning the amount of work needed to assure reasonable chances of detection of the minimum amount of change considered important. For example, a change in area of + 20 percent might be set up arbitrarily as the least that would indicate worth-while treatment effect. Knowing the standard error and given the difference. it is desired to be able to detect methods described by Neyman[1] may be used to determine the probability of detection. Reasonable chances of detecting changes of 20 percent by taking two 12-chain lines in each 1 by 12-chain block are indicated in the following table:

| Cover-type | Original distance through type [1] | Change of 20 percent[1] | Standard error of difference[1] | Probability of detecting change at 0.05 level of significance |
|---|---|---|---|---|
| | | Plot A 9.6 acres | | |
| Reproduction | 287 | 57 | 21 | 0.78 |
| High brush | 446 | -89 | 17 | 0.99 |
| Bear clover | 284 | -57 | 16 | 0.94 |
| | | Plot B 10.8 acres | | |
| Reproduction | 291 | 58 | 25 | 0.68 |
| High brush | 300 | -60 | 21 | 0.83 |
| Bear clover | 304 | -61 | 14 | 0.99 |
| | | Plot C 10.8 acres | | |
| Reproduction | 331 | 66 | 19 | 0.93 |
| High brush | 266 | -53 | 22 | 0.70 |
| Bear clover | 276 | -55 | 12 | 0.99 |

1/ Number of half-foot units per 12-chain line.

1/ Neyman, J., Lectures and conferences on mathematical statistics. pp. 60-61. The Graduate School of the U. S. Dept. Agriculture, Wash. 1937.

It was found that the chances of detecting changes of 10 percent were about the same as the above for 20 percent, if 2 lines were taken in each 1/2 by 12-chain block.

An important advantage over mapping is that different men agree closely on type classification along lines, whereas in mapping it is difficult to attain and maintain consistency. Differences shown by maps are a combination of real changes in vegetation-type areas and false differences due to lack of consistency between mappers.

## Central States

### Tree Studies

Converting Factors. During this summer, some 55 piles of white oak 39-inch stave bolts, varying in content from 0.86 to 7.70 cords, and 16 piles of 23-inch heading bolts were measured. These data have been compiled and a progress report prepared. For the 39-inch bolts, strong averages of net chord-feet per cord resulted, but for the heading bolts only approximate factors are available because of the few data comprising the basis.

Seizert, on the Clark National Forest, has begun measurement of trees for chord-foot - board-foot volumes; and Bixby on the Mark Twain has measured all available piles of bolts and at the end of the summer's recess from cutting in the stave business, about October 15, will take additional data.

### Volume Tables

The reworking of volume table data provided by the Ohio Woodland Survey from Stark County, Ohio, was completed during the summer. It provided nine tables of tree volume by the International Rule (1/4" Kerf) for hardwoods reading in diameter b.h. and merchantable length in 12.3-foot logs to variable top diameters. Adman's procedure for preparing an equation for each table, allowing for a variable top diameter, worked smoothly and required only minor adjustments for species differences.

In September, the Ohio Woodland Survey provided sets of volume table data from Hamilton County, Ohio, for yellow poplar and sugar maple.

Other sets of data for black maple and sugar maple taken on a local blowdown in Marshall County, Indiana, are now in the process of compilation.

Plans are under way to take volume table data on timber sales on the Illinois National Forests, for compilation at this Station.

Pacific Northwest

Cooperation with U. S. Indian Forest Service. The Experiment Station is cooperating with the Indian Service on the Colville Reservation in an attempt to provide reliable growth estimates for use on the Omak-Okanogan cooperative sustained yield project. Seven new permanent sample plots ($2\frac{1}{2}$ to 5 acres each) have been established by the Indian Service in residual ponderosa pine stands that were cut over a decade or so ago. Plots were put in according to Station technique and each tree bored to determine the growth since cutting. The total growth thus measured checks very closely with that estimated for each plot using the Station's latest technique. Mean deviation per plot was only 3 percent. Trees on the plots were classified by Keen tree class but for growth estimating purposes were grouped into Dunning classes since the bulk of the Station's growth data are in such terms. This is the first definite check on the accuracy of this procedure and the results to date are gratifying. Briegleb spent several days on the Colville Reservation during the progress of the work and assisted in coordinating the technique employed and in laying plans for the analysis, interpretation, and application of the data.

## REGENERATION

Allegheny

Prior to his resignation to accept outside employment, Hetzel completed analysis of his data from 73 older plantations in northwestern Pennsylvania and prepared a report in rough draft for publication.

Central States

Regeneration in the Farm Woods. During the period August 7 to September 6, the final ten-year remeasurement was taken on the reproduction quadrats established in cooperation with Purdue University. The study was started to gauge the rate at which seedlings establish following the removal of livestock from the farm woods previously grazed, and to observe its character, composition, and rate of growth. John R. Wilson was the Station's representative on this work, which completes the taking of data on this study.

Nursery Soils. Three years' investigation on response of nursery soil to fertilization and soil amendments has been completed and the report is being written as fast as the statistical analyses

areavailable. During the summer by the help of a WPA project under the guidance of a statistician, the data were subjected to variance analysis. The report will be submitted in the form of a technical note. This investigation covers the development period of three new Federal forest nurseries.

Lake States

Cross Cultivation Aids Planting at Denbigh. Most of the early planting at the Denbigh branch was done in furrows without follow-up release from plant competition. Since trees came through on the Nebraska National Forest without any follow up, why shouldn't they in North Dakota? Although many of the North Dakota plantings survived, growth was practically at a standstill. Consequently ground preparation with a Hester plow was tried, leaving strips of sod between the 5-foot furrows as protection against soil blowing. Results were better but not yet satisfactory. Then one-way cultivation was tried after widening the Hester furrows to make room for the cultivator. Results improved but were not good enough. This year it was decided to take a chance with soil blowing and cross cultivate cottonwood plantings. The results have been most gratifying. The 1-year-old plantings look as good or better than others that are 3 to 5 years old. Moisture samples serve to explain the results. The total average moisture percent for 0-4 feet was as follows in one set of samples taken this summer:

| | | |
|---|---|---|
| Cross-cultivated 50-foot-wide strips | 4.30 | percent |
| Hester furrow..... | 2.63 | " |
| Native sod..... | 1.60 | " |

The increased moisture content is due to elimination of the competing weed growth.

So far, soil blowing has not been a factor, and it is believed that the cottonwood trees in another year will be large enough to hold in check any wind erosion. In 3 to 5 years a good tree cover should be established.

Rocky Mountain

Deep Furrows Benefit Survival. The experimental plots established in 1940 on the Pike National Forest to test the effect of size of ponderosa pine 2-1 planting stock were contour furrowed and the trees were planted in the furrows. On two plots the furrows were about eight inches deep, while on the third plot the furrows were only three to four inches deep. The plot with shallow furrows was a replant of a 1939 plot which was a complete failure

on account of the exceptionally severe drought of that year. All trees on the third plot were planted in the old holes of the dead trees.

The total survival in the deep furrows was decidedly better than in the shallow furrows. Also the differences in survival between the size classes were much more pronounced in the shallow furrows. In the deep furrows only the small trees with poor root systems showed a significantly lower survival, whereas in shallow furrows survival decreased consistently with size of planting stock.

The following table shows the average survival in percent for the different treatments according to a count made in October 1940.

Ponderosa Pine Plantation
Spring 1940

| Size | Root systems | Average survival - percent, fall 1940 Deep furrows | Shallow furrows |
|---|---|---|---|
| Large | Good | 88 | 50 |
| Medium large | Good | 89 | |
| Medium small | Good | 81 | 48 |
| Medium small | Poor | 71 | |
| Small | Good | 75 | 10 |
| Small | Poor | 48 | |

Southern

Nursery

Compost-Density Study. Final typing is in progress on a report by Muntz covering in detail a study made at the Stuart Nursery in 1938, to determine the relative effectiveness of various applications of compost (artificial manure) in increasing the capacity of the nursery soil to produce longleaf and slash pines in stands of varying density. Compost was tested at the rates of 0, 1, 2, and 3-inch applications, and density at the rates of 10, 20, 30, 40, and 50 seedlings per square foot. The compost used consisted mostly of rice straw treated with ammonium sulphate, rock phosphate, and lime, and subjected to decomposition for about 7 months.

The study occupied four 4' x 100' nursery beds, with the smallest areal unit of treatment (4' x 5') assigned to density; compost was tested on areal units of 4 x 25 feet. Statistical design permitted an analysis of variance to be applied to the results, using a rather complex, novel statistical technique.

These results were evaluated on the basis of measurements of top length, stem diameter, root length, root extent, green weight, and plantable percentage. These quantitative data were supplemented by pertinent observational notes, such as the effect of compost on bed preparation, germination and initial seedling establishment, form of root development, chlorosis and growth of weeds.

With respect to compost, the outstanding result was the definite superiority (expressed in terms of seedling size) of seedlings treated with compost over those not so treated. Furthermore, there appeared to be little or no difference in the effects of the three amounts tested; one inch of compost was just as effective as either 2 or 3 inches. However, several objectionable features to the use of compost were revealed; the weed problem was intensified, chlorosis developed slightly in spots, abnormal (crooked) root development occurred in some cases, and bed preparation was hindered. None of these features proved to be really serious; they can all be prevented or minimized.

The results of the density phase indicated that in general the size and grade of the seedlings decrease as the density increases. Exceptions to the general statement, such as the tendency for the height to increase to a density of 30 followed by a decrease, is explained somewhat in detail in the report. As to plantable percentage, every increase in density showed a significant decrease. The study further indicated that as the soil fertility is improved by the use of compost, desirable seedlings may be raised at densities higher than are normally used.

Seed Studies

Estimate of the 1940 Cone Crops. During August the tenth annual estimate of the cone crops of southern pines was completed and mailed to forestry agencies and cooperating reporters. The greater part of the information sent in by these reporters reached the Station on forms showing species, location, and "not less than 0, 5, 50, or 500 bushels of cones on (approximately) 10, 100, or 1,000 acres" -- with check-marks indicating which number of bushels and acres best described the crop observed.

Standard or regular reports covering 696 items were submitted in this manner by 199 individual reporters. In addition, these and 31 other reporters submitted 186 irregular items, many of them very detailed and valuable. Thus the total number of reporters was 230; of items reported, 882.

The 1940 cone crops of the southern pines are in general light to poor. No locality of heavy production is noted for any species. There may be difficulty in collecting slash pine seed anywhere in its range, or shortleaf pine seed west of the Mississippi River.

The cone crop of longleaf pine is light to fair over most of its range, but spotty, poor, or a failure in central South Carolina, east-central Mississippi, central Alabama, and most of Florida.

Except possibly in southeastern Louisiana and the adjacent counties of Mississippi, the cone crop of slash pine is poor or very poor. Experienced collectors report poor prospects for collecting in Georgia. A practical failure is reported from South Carolina.

The cone crop of loblolly pine is good but spotty in Virginia, the Carolinas, and northeastern Georgia, and in southern Mississippi and southeastern Louisiana; it is light to poor and generally very spotty in the inland portions of the loblolly pine range. A potentially good crop has been noted in Delaware.

Light to fair crops of shortleaf pine cones are reported from eastern Virginia, central North and South Carolina, and northeastern Georgia, and from Mississippi. Elsewhere the shortleaf pine cone crop is light to spotty, poor, or very poor, especially at the western edge of the species range.

The cone-crop estimates were originally undertaken with a three-fold purpose: (1) to show the localities of good and of poor seed production, for the benefit of those undertaking to collect seed or to reproduce stands by natural means; (2) to serve as a clearing-house for seed collecting efforts (by listing local collectors and seed dealers); and (3) to accumulate fundamental data on the periodicity of seed production among the southern pines. Decision as to whether the third purpose is being fulfilled and perhaps as to whether the annual estimates shall be continued must wait on a complete analysis of the records for the past ten years. It is planned to make this analysis this coming winter. Meanwhile, to learn the usefulness of the estimate and the burden it placed upon the cooperating reporters, a questionnaire was sent to all reporters and forestry agencies receiving the report. To date, 200 individuals have replied, of whom 90 percent desire the continuation of the estimate.

## SILVICULTURE

### Allegheny

General. A problem analysis for the oak-pine region of the Coastal Plain was completed and a good start made on one for the beech-birch-maple-hemlock region of the Allegheny Plateau.

Silvics. Analyses of seven years' weather records from four stations on the Kane Experimental Forest were made. The results indicate clearly the moderating influence of tree cover on microclimatic factors and the influence of topography and cover on frost pocket conditions on the Allegheny Plateau. The gross effect of topographic location, aspect, and slope on the composition of second growth recorded on 68 plots from 17 localities on the Allegheny Plateau was shown to be significant for certain tree species.

A start has been made on an ecological study on lowland sites in southern New Jersey as a basis for Atlantic white cedar management. White cedar has the highest per acre value of any species in the Station territory, and the possibility of extending the type is of commercial importance.

Appalachian

Epicormic Branches on Chestnut Oak. Measurements of 125 chestnut oaks reserved after partial cuttings provide definite information on the formation of epicormic branches. Nearly 70 percent of the trees produced one or more epicormic branches during the three years since release. The increase in the number of limbs below the base of crown is definitely correlated with the diameter of the tree, shown in the following table for trees having two 16-foot logs.

| D.B.H. (inches) | Number of branches per tree produced during 3 years |
|---|---|
| 10 | 6.0 |
| 12 | 4.7 |
| 14 | 3.8 |
| 16 | 2.3 |
| 18 | 2.2 |
| 20 | 2.3 |
| 22 | 1.7 |
| 24 | 0 |
| 26 | 0 |
| 30 | 2.3 |

Epicormic branches generally are formed first on that part of the bole immediately below the base of crown and develop later on the lower parts of the bole. The 2-log chestnut oaks had an average of 0.3 limbs in the lower log and 2.4 limbs in the upper 16-foot log. Only 27 percent of the trees produced epicormic branches in the lower log, and 67 percent formed branches in the upper log.

Further study is proposed for investigating the effect of such variables as slope, degree of bole exposure, intensity of cut, character of crown, etc., upon the formation and development of epicormic branches.

California

Redwood Region

General. Examination and surveying of the newly established Yurok Redwood Experimental Forest and getting the headquarters building well under way have occupied most of the field season except for the time needed for scheduled examinations of reproduction quadrats and planted tree growth plots. Person has also spent some time assisting in the follow-up on the redwood lumber census.

Harvest Cuttings. Advantage was taken of Dr. Haig's visit to discuss the general program of research to be undertaken in the new Yurok Redwood Experimental Forest. Conferences on the forest and in the office were participated in by Haig, Dunning, Hasel, and Person.

The major problem is the conversion of virgin stands to fully productive managed stands with a minimum of delay and expense. This calls for a careful selection of the trees to be removed at the initial and subsequent cuttings. Because of wide variations in redwood stands with respect to density, age, tree size, and proportion of associated species, as well as site and topography within small areas, methods used in many pine stands will not be practicable. A combination plot and individual tree sampling will probably be necessary to work out the major problem: determining the responses of different classes of redwoods to different spacings on the various sites involved. Even the development of a suitable tree classification is exceptionally difficult in redwood because of the extreme range of redwood age and size, the difficulty of classifying crown characteristics in virgin stands, and the unusual vitality of redwood trees, which permits acceleration after release of large trees which would normally be considered overmature. These difficulties have been encountered in previous attempts to classify trees and logs such as in the Henry Creek study.

To date the most promising tree classification character is the bark and attempts will be made to correlate bark characters -- color, width, and depth of ridges, texture, and hardness -- with age and rate of growth for the preceding 100 years or so. After a tentative classification has been decided upon it will be checked on the Henry Creek area where responses to release 5 years after cutting can be determined for the different tree classes.

Central States

Timber Conversion. A study plan for the Sylamore Experimental Forest timber conversion study was prepared during September, in cooperation with Region 8 and the Forest Products Laboratory. The study involves gathering data over approximately 240 acres of

the Sylamore Experimental Forest, which at present is being selectively logged by a local sawmill operator. Data on volume, quality of product, and condition of the remaining stand will be taken.

Silvics

Measurements of growth plots and natural regeneration plots at the Southern Illinois Experimental Forest were completed during June. The data provide the first five-year records of growth conditions in the Illinois Ozarks.

The general distribution of shortleaf pine in the Missouri Ozarks was mapped during the summer. Several copies of the maps have been made and are being sent to the foresters working in Missouri for a final check before the map is published.

Forest Soils. The soil profile - tree investigations begun in 1930 with a study of virgin woods and continued in succeeding years with studies of soil - tree species relations of natural and planted stands of black locust, black walnut, pines, yellow poplar, and sassafras were completed in 1939. The report has been written as a technical bulletin and is now being edited by a member of the Washington Office editorial staff.

This bulletin will represent a compilation and coordination of ten years of soil research applied to problems of reforestation in the Central States. With a background of the virgin wood soil profile defined in terms of litter, organic matter accumulation, rates of infiltration, porosity, and fertility; deterioration brought about by deforestation, cultivation, fire, grazing, and erosion are pictured by contrast. The physical and chemical properties of soil profiles are analyzed with reference to growth of several tree species; and the restoration of the degraded forest soil profile under four tree species is reported.

Missouri Ozark Project

Two additional sets of soil samples, for moisture determination, were taken on the 60 reproduction release plots in Missouri during July and September. Some of the data have been summarized. Apparently the percentage of moisture in this top six inches of soil on the released plots is higher than on the check plots during the dry summer months.

Intermountain

Silvics

Ponderosa Pine Seed Production. The 1940 seed crop of ponderosa pine in central Idaho is one of the heaviest recorded

since intensive measurements were started at the Boise Basin Branch Station in 1934. The catch of seed in 100 seed traps, as examined on September 16, exceeds that found on the same date in 1936, which year has been considered the standard of "very heavy" seed production up to date. The following table gives a comparison of seedfall up to September 16 for the two years.

| Character of stand | Average number of seed per milacre (or number of thousand seed per acre) | | | |
|---|---|---|---|---|
| | Ponderosa pine | | Douglas-fir | |
| | 1936 | 1940 | 1936 | 1940 |
| Virgin forest | 72.0 | 254.5 | 7.7 | 124.8 |
| Selectively cut in 1933 | 161.4 | 202.7 | 57.6 | 88.0 |
| Second growth (age - 70) | 72.7 | 243.0 | 0 | 4.5 |
| All stands (wt'd. av.) | 123.7 | 222.6 | 35.1 | 82.5 |
| Percentage of seed sound (cutting test) | 85.4 | 81.2 | 28.0 | 27.9 |

The relative seedfall in the virgin, selectively cut, and second-growth stands differs considerably in the two years, without any obvious explanation at this time. It must be recognized, however, that these figures represent only a part of the total seed yield for the year. In 1936, about 65 percent of the total catch of pine seed for the year was obtained by September 16; this proportion may be greater for 1940 as the season was more advanced in general than normal. Either the total productions or the proportion falling early must have varied in the three adjacent areas sampled. The seedfall of Douglas-fir likewise shows a large increase over 1936 and wide variations in the three types of stands. The excessive increase shown for the virgin forest is especially puzzling.

The years 1937, 1938, and 1939 brought light seed crops of both pine and fir. As no collections were made in September of those years, no direct comparison is yet possible, but it may be noted that the total catch of seed for the year was as follows: Ponderosa pine: 1937 - 8.1 thousand per acre; 1938 - 7.3; and 1939 - 10.8; Douglas-fir: 1937 - 22.4; 1938 - 23.7; and 1939 - 8.6. The "effective seedfall" was even less, as the percentage of sound seed was lower than in good seed years. The percentages of soundness were as follows: Ponderosa pine: 1937 - 56.9 percent; 1938 - 61.0 percent; and 1939 - 34.7 percent; Douglas-fir: 1937 - 8.4 percent; 1938 - 32.1 percent; and 1939 - 1.9 percent. Many other facts and figures are to be derived from the data, such as information on distance of dissemination from seed trees, but these will not be compiled until the full seedfall for the year has been collected from the traps.

Lake States

One Disaster after Another at Chippewa Branch. The elements, apparently not content with wrecking the Cutfoot Experimental Forest by the heavy ice glaze of April 2, completed the destruction for some time to come (we hope) through the action of wind late in July. The Chippewa National Forest was swept by a storm of hurricane proportions on July 24. The Cutfoot area fortunately escaped but the Pike Bay Experimental Forest was directly in the path of the storm. As a result, the aspen cutting plots and some of the large partial-cutting demonstrations scheduled for cutting in 1945 will have to be cut this year. Cutting will also be required in several additional uncut areas to salvage the down timber. Clear cutting will be necessary in areas hard hit by the wind, since the remaining stand is too light to hold up for any length of time.

Jack pine thinning plots on the Black Duck road already damaged by the April glaze lost still more trees in the July wind. One plot is now too far gone to keep. On the others a "commercial" thinning is being carried out to salvage losses and put the plots in shape for continuance of the original spacing test.

The northern hardwood type at Pike Bay stood up remarkably well and suffered very little loss except for a few white pine and white spruce seed trees. On the whole, the loss in experimental plots was much less in the July windstorm than in the April ice storm, although the Chippewa Forest as a whole suffered much more in the windstorm.

Salvage of the glaze damage on the Cutfoot Experimental Forest is now nearly complete. All sample plots except one set in 80-year-old red pine-jack pine were lost. It will be necessary to recruise the whole tract in order to find out what is left to manage.

The one bright spot is the report of Dr. MacAloney that the insect (budworm and sawfly) epidemic on jack pine at Cutfoot that has been in progress for several years is now subsiding. This epidemic is believed to be tied in with the 1936 drought and overmaturity of the stand.

Black Spruce Experiments. The State of Minnesota is the owner of extensive areas of black spruce timber which were largely obtained through the Swamp Act and other land grants for schools. Earlier efforts to convert these forested swamps to farm land by draining were frequently unsuccessful, and the policy now is to hold them for timber production. This Station recently cooperated with the Minnesota Forest Service in starting a series of plots on which three methods of cutting and four kinds of slash disposal will be studied.

The usual cutting policy of the Minnesota Forest Service (take only such trees as will make 3 or more 8-foot pulp sticks)

will be compared with (1) a diameter limit rule that will permit cutting of only about 30 percent of the merchantable volume, and (2) a selection marking system which will take about 30 percent of the merchantable volume and leave the soundest and thriftiest trees.

The slash disposal methods which will be tested include (1) lop the tops, which is the usual State requirement, (2) pile slash compactly, (3) pile and burn, and (4) leave tops and limbs as they fall. Lopping the tops, as required by the State, has some merit as a fire-hazard-reduction measure, but it has the serious drawback of creating an almost continuous carpet of slash, on heavy cuttings, that smothers established seedlings and prevents the establishment of many new ones. Observations have suggested that the choppers' preferred way of handling the slash, by allowing the tops to remain whole in crude windrows, leaves more of the ground surface exposed for reproduction. Piling the slash compactly, and piling and burning the slash, are being tested as possible methods for greatly increasing the ground exposure and at the same time satisfying the demand for fire hazard reduction.

The project will be carried out on a going commercial sale, with some help from CCC's for piling and burning slash.

Northeastern

Phenological Investigations. A recent survey of the last ten years' phenological investigations at this Station indicates: (1) a waning interest on the part of cooperators; (2) a comparatively small number of complete records -- less than 25 percent of the reports are 76 percent or more complete; (3) that exact data have not been obtained because present criteria of phenological events are so indefinite that they permit wide variation of interpretation; (4) that many cooperators apparently have not used the same individual trees or even the same stands from year to year, thus introducing individual tree variations and site differences as unknown quantities; and (5) that the data obtained by this cooperative project during the past ten years are not exact enough to be correlated with exact meteorological data.

Careful consideration of all aspects of this project has led to the following recommendations: (1) All data should be summarized as early as possible -- the information, though far from exact, will serve to answer general inquiries. (2) The collection of these cooperative phenological data should be discontinued because general questions probably can be answered by the empirical data now at hand, and continued effort along the same line will hardly justify the expenditure of technical time involved. (3) Additional work on phenology should not be undertaken until it can be adequately financed. Preliminary research requiring not less than one technical man for several years should first be directed toward the selection

of phenological events which are of particular physiological significance in the life of the plant and which tie in directly to research or practice, and toward the development of criteria and descriptions of these events which will be sufficiently exact to permit reasonable correlation with exact meteorological records. (4) The annual compilation of "character of seed crop", gathered in connection with the phenological cooperation, may well be continued as long as there appears to be a demand for this type of information, particularly since "good", "fair", "poor", or "none" is reasonably easy to determine.

-- Ernst J. Schreiner

Note: Schreiner's note on phenology is of particular interest, for many of us, both in Washington and at the stations, have been questioning the value of long continued phenological records as such. If the objective is general information only, then perhaps reliance upon cooperation is sufficient and a few years at most should give all the data needed or worth summarizing. If the phenological record is a part of a programmed study it is a different matter, of course. It is then like any other part of a study, loses its identity, and takes on the same importance as the study of which it is a part.

-- V. L. Harper, W.O.

White Pine Sun Scald Study. A study is being developed to determine the causes and effects of sun scald, involving the influences of season, shade, and direction of exposure. At the Massabesic Experimental Forest an experiment has been set up to determine whether significant differences in occurrence of injury result from time of exposure, shade produced by screen and direction of exposure, or by various combinations (interactions) of time, direction, and shade. There will be two blocks, two periods of exposure (July 1-15, Dec. 1-15, and check), three directions (SE, S, SW), and four degrees (0, 25%, 50%, and 75%) of shade. The periods for treatment are selected to provide for exposure to the following conditions: hottest part of the year (July, August); and freezing and thawing in the early afternoon (December, January). These dates may have to be changed somewhat, depending on weather conditions. Each treatment, consisting of one time, three directions, and four shades, will be applied per tree. There will be six trees per block, two replications per treatment, or a total of 12 trees for the experiment, with 12 observed areas per tree, or 144 observations, in what might be called split-split plot design. The observation will consist of determining whether or not a given area shows injury within three months after treatment and the width of such injury; the basis for comparison will thus be the width of areas injured. The treatment will consist of exposing the trees of about 5" d.b.h. at the proper time by cutting enough neighbors so that it will be shaded on the north only. It may be necessary to prune some branches also. The shades will be 12" apart, and their positions will be determined by random selection. The check treatment will consist of leaving neighboring trees and branches to provide natural shade, and

application of the screen shades in addition. This check "treatment" will be applied the same time as the July treatment. The July exposed trees will have their trunks covered before December. Trees will be observed periodically and record kept of occurrence and progress of injury by tree, direction, and shade condition.

Development of Residual Northern Hardwoods. Four-year remeasurements of a two-acre cut-over area in Vermont provide an indication of the development of residual northern hardwood stands following the usual commercial high-grading practice. Prior to cutting, the area supported a typical old-growth stand having a basal area of about 150 square feet per acre (minimum 3-inch DBH class). The operator cut almost half the volume removing all trees he considered merchantable on this relatively inaccessible area. Aside from beech, of which only a few exceptionally good trees were cut, the residuals were below merchantable size, approximately 10" DBH, of poor form, or showed external evidences of decay.

An analysis of the species response to changes following logging in general confirm results obtained in other sections of the northern hardwood region. Yellow birch losses in the residual stand were extremely high, 24 percent, while 4 percent (by volume) of the beech died over the 4 years subsequent to logging. In spite of losses resulting from exposure, beech showed a net gain in volume over the 4-year period. Sugar maple, although surviving, made relatively slow growth, while ash maintained its excellent growth rate. Had the softwoods been scattered rather than occurring in groups, some trees would undoubtedly have died. The net percentage changes in volume (basal area) over the period were as follows:

| | | | |
|---|---|---|---|
| Beech | + 3.5 percent | White ash | + 8.4 percent |
| Sugar maple | + 2.2 " | Eastern hemlock | + 2.8 " |
| Yellow birch | -22.6 " | Red spruce | + 4.5 " |

Growth on this area was not only slow but was largely on defective trees or trees of poor form. Reproduction was generally unsatisfactory, striped maple, crooked beech, and in the larger openings pin cherry dominating limited amounts of sugar maple and white ash. Although eventually this area will produce another merchantable stand, girdling or cutting the worthless overstory would insure a larger volume of better trees at an earlier date.

Reinstatement of Cutting Experiments. The widespread damage to second-growth stands of spruce by the hurricane of 1938 introduced the problem of finding suitable areas for reinstatement of damaged and wrecked cutting experiments. A special effort to replace the partial cutting experiment in second-growth spruce on the Gale River Experimental Forest has met with some success. Aside from the prospect of getting a comprehensive set-up on the Finch Pruyn Company holdings in the Adirondacks, progress in this respect was made on a small scale on a portion of the Gale River Forest least damaged by the hurricane.

Two series of partial cutting plots were established, one dealing with pure spruce-fir stands, the other with mixed stands, consisting of spruce and fir with admixtures of northern hardwoods. The objectives of the experiment are to determine:

1. The practicability of light but frequent cutting in second-growth spruce stands of varying composition.

2. The yields which will result from leaving varying amounts of growing stock after cutting.

3. The feasibility of developing and maintaining large amounts of growing stock and integrating pulpwood and sawtimber production.

4. The feasibility of converting even-aged stands of spruce and fir into all aged stands.

5. The degree of cutting most favorable to spruce regeneration.

Because of the limited area left suitable for the experiment by the hurricane, a completely satisfactory experimental design was not possible. However, the experiment provides replications of the following treatments:

1. Pure conifer stand

   Basal area reduced to 80, 100, 120, 140, 160, and 180 square feet per acre.

2. Mixed conifer-hardwood stand

   Basal area reduced to following square feet per acre:

| Softwoods | Hardwoods | Total |
|---|---|---|
| 60 | 30 | 90 |
| 60 | 40 | 100 |
| 80 | 20 | 100 |
| 80 | 30 | 110 |
| 80 | 40 | 120 |
| 100 | 0 | 100 |
| 120 | 0 | 120 |

The original basal area in the pure coniferous and mixed conifer hardwood stands averaged 175.6 and 166.2 square feet per acre respectively. The cutting experiment contains 32 plots averaging approximately a half-acre each in size. The cutting on the plots has been nearly completed and has been done in conjunction with a sale of hurricane-damaged timber to the Parker Young Company, a pulp and paper concern about 20 miles distant from the forests.

Excellent progress has been made in cleaning up the forest of down and damaged timber, the Parker Young having removed to date the following:

2,000 cords of spruce fir pulpwood
1,267 cords of fuelwood
168 cords of white birch bolts
140 M feet of hardwood sawlogs
18 M feet of white pine sawlogs

In addition to the above, approximately 800 cords of fuelwood have been removed from damaged areas by the CCC. Further clean-up is being obtained through small sale of fuelwood to local residents.

Pacific Northwest

Douglas-Fir Silviculture. The study of shade tolerance of Douglas-fir seedlings at the Wind River Experimental Forest was the most important natural regeneration activity. Much more consistent results than heretofore were obtained this season in light measurements with both Livingston cup atmometers and with photometers. It was accomplished with the atmometers by attaching two instruments to the same reservoir, thus doubling the evaporating surface. With photometers more consistent results were obtained by developing a metal frame for holding the instrument and a standard reflecting surface, which made possible the taking of every reading from exactly the same angle and distance from the same reflecting surface.

In the partial cutting studies most of Isaac's time was required to make the annual examinations of sample plots established during the past three years on selectively cut areas. One compound plot of three acres was established in a thrifty middle-aged Douglas-fir stand, averaging 148 M feet gross per acre, at Westfir, Oregon, from which 30 percent of the volume is to be removed by individual tree selection.

A number of other cutting areas were examined, both on private and national forest lands, as a means of crystallizing the problem that is before us in trying to study the form and extent of the applicability of selective cutting to the very variable stand structures and types that occur in the Douglas-fir region.

At Wind River the detailed study of stand structure was continued by the laying out of a 16-acre plot in typical overmature Douglas-fir which was subdivided into quarter-acre plots and the trees on each tallied by quality as well as volume. Still another plot will soon be put in as a basis for analyzing the possibilities for group selection cutting in contrast with individual tree selection

and to make paper markings of various kinds with a view to determining what type of reserve stand will be left with various degrees of cut.

Forestation. The only current work of consequence was some small studies aiming toward knowing more about the practicability of direct seeding. At Wind River some germination tests were run with seed coated with plaster of Paris, yellow dextrin, and cornmeal as a carrier for arsenic to determine the effect of this coating on germination, it being reported that this coating affected Douglas-fir though not western white pine. The germination tests of both Douglas-fir and ponderosa pine showed no unfavorable effect from the coating. A small test was made of Douglas-fir seed that had been treated with Port Orford cedar oil, it having been reported that Port Orford cedar oil was a deterrent to mice depredations. The oil-treated seed absolutely failed to germinate. It should be understood, however, that there are various fractions of Port Orford cedar oil and other fractions than the one we used may be less lethal to the seed. An elaborately laid out test of seed spot sowing with 2, 3, 5, and 10 seeds per spot on burned-over logged-off land near Cascade Head has so far failed to show that there is any proportionally better seedling establishment with the few seeds than with the many seeds per spot, it having been proposed that rodents were less likely to discover the spots with few seeds than those with many seeds.

Ponderosa Pine Silviculture. This has been practically at a stand-still this summer except for the maintenance of the several permanent plots at Pringle Falls.

Stand Improvement. During the summer Kachin scouted out areas and outlined plans for CCC stand improvement work on the Deschutes, Siskiyou, Willamette, and Olympic National Forests, and gave technical guidance on the ground to the new projects at the start of work. The crop tree release and pruning on the Siskiyou, the first ever done in the Port Orford cedar type, is designed to increase the proportion of valuable Port Orford cedar by removal of competing Douglas-fir. Current work on the Olympic consists of crop tree pruning of second-growth Douglas fir. Two pormanent sample plots, one thinned and one check, which were established ten years ago by Olympic Forest personnel, were remeasured.

Computations were completed and reports prepared for two pairs of ponderosa pine sample plots, one thinned and one check each, established ten years previously on the Whitman National Forest at Susanville and on the Malheur at Crow Flat. On the heavily thinned plots on the Whitman diameter growth was more than double that on the check, while at Crow Flat a similar treatment in an extremely stagnated sapling stand increased diameter increment seven-fold over that on the unthinned plot. The thinning had little effect on height growth on the Whitman, but about doubled that occurring under extreme competition on the Malheur.

At Pringle Falls Experimental Forest Kachin assisted McKay in planning a series of plots on unthinned and thinned-from-above stands in 90-year-old even-aged ponderosa pine which have now been established, and prepared a plan for the continuance of this thinning study with three other types of selection.

Damage to Douglas-Fir from Use of Climbers. Existing evidence seems to indicate that the most efficient method of high-pruning Douglas-fir may be by using handsaw and Hebo club from tree climbers with safety belt. That some damage is done to the tree in this operation is clearly recognized, and in an attempt to determine its extent trees along the abandoned Wind River-Red Mountain trail that had been climbed with spurs during telephone work 20 to 30 years ago were felled and dissected. Findings in brief from this preliminary study are:

1. No evidence of decay entrace due to spur climbing was found.

2. The average wood-puncture with its distorted grain following healing is confined to a block extending one inch radially, one inch tangentially, and two inches vertically.

On young, vigorous trees such as are commonly chosen for crop trees such injury should be completely covered at least as soon as the branch stubs left following pruning are occluded.

The equipment laboratory has been asked to design a type of climber for young Douglas-fir whose spurs will not puncture the wood, if such a thing is practicable.

Growth of Even-Aged Douglas-Fir at Wind River. A report prepared during the summer summarizes results of last fall's and all previous measurements of the 8 permanent sample plots in Douglas-fir second growth in the Wind River Valley. Three of these plots established in 1914 are the oldest in the State of Washington. In growing from 72 to 98 years of age on site III+ average living volume per acre has increased from 42,500 to 63,200 board feet, Scribner rule, a periodic annual per-acre growth rate of 796 board feet. Average annual mortality suffered during this same period totaled 350 board feet per acre and was caused principally by bark beetles (Dendroctonus pseudotsugae) and partly by windfall. This heavy loss bespeaks the need for intermediate cuttings in second-growth stands of advanced age. Had it been salvaged it is evident that net growth would have been increased 44 percent thereby.

In a decade of growth from age 26 to 36 years the live stand on 3 plots on site IV increased from 1,410 to 3,160 cubic feet per acre, a growth of 124 percent. At the same time board-foot volume by International rule jumped from 1,630 feet to 10,200 feet per acre, owing largely to recruitment of many trees into the 7-inch and larger d.b.h. class.

Growth of Spruce-Hemlock at Cascade Head Experimental Forest. Eleven permanent plots that were established five years ago in the high-yielding, even-aged, spruce-hemlock type, and one in Douglas-fir were remeasured during September. Two new plots in Douglas-fir type were established to supplement the comparison of the yield of these two important types on similar sites. Computation of these measurements is already under way.

## Rocky Mountain

Bouyoucos Soil-Moisture Measurements. In early August a series of 18 Bouyoucos plaster-of-paris blocks was installed for a test of this method of electrically measuring soil moisture. Paired blocks were placed at depths of 6, 12, and 24 inches in three sites: directly under the crown of a small lodgepole pine and close to its trunk; under the edge of the crown; and in an adjacent opening. The blocks were inserted in the edge of a pit, and the pit refilled with soil in layers, tamped to original density.

Daily measurements of electrical resistance showed a progressive drying of the blocks, especially at the two shallower depths. Although at first the paired resistance readings showed fair correspondence, striking discrepancies occurred at high resistances. A part of this variation may be attributed to the Bouyoucos bridge; it was quite difficult to establish a null-point for resistances above about 40,000 ohms.

On September 17 the study was dismantled. As each block was carefully removed, a soil sample was taken and immediately weighed for soil-moisture determination; observations were also made of the condition of each block, its tightness in the soil, and related factors. All of the blocks appeared to be rather friable, and quite chalky in consistency.

Soil moisture plotted against block resistance showed a disappointing lack of correlation, which was not improved by allowing for variations in gravel content of the soil. Although the blocks showed considerable reaction to variations in moisture, no reliable calibration curve could be obtained. These results may be due, at least in part, to the gravelly character of the soil, which contained 24-57 percent of particles over 0.2 millimeter in size.

## Southern

### Silvics

During the past year several species of trees were planted on savannas on the DeSoto National Forest in the vicinity of the Harrison

Experimental Forest in Mississippi. The purpose of the plantings was to determine whether it is possible to grow commercially important tree species in savannas, which are numerous and extensive in the South. It is estimated that in the Florida National Forests alone there are more than 10,000 acres of this type of land, which at present is entirely unproductive. Valued at least at $2 an acre, there is an investment of $20,000 which is not likely to bring any returns. Obviously anything that can be done to make these savannas productive is worth while. It was felt that if water-loving, commercially important trees can be grown in the savannas, they might serve not only as crop trees which may yield a revenue, but also would aid in draining these wet lands, thus preparing them for the next planting, which could be slash pine or some other less hydrophyllous species.

As a start in this direction, cuttings were obtained from ten cottonwood hybrids developed at the Northeastern Forest Experiment Station. In addition 50 seedlings of Populus alba (1-0 stock) and the same number of Salix alba var. vitellina were obtained from the Soil Conservation Service nursery at Albuquerque, New Mexico. The cuttings were planted January 5, 1940, and the seedlings were planted two months later. Observations on survival were made in June following planting and again in September. Below are tabulated the results obtained after the completion of the first growing season:

Survival of cuttings and seedlings planted in a savanna on the DeSoto National Forest, Miss.

| Species | Class of stock | Designation | Percent survival | |
|---|---|---|---|---|
| | | | 6/10/40 | 9/24/40 |
| Populus maximowiczii x P. berolinensis | Cuttings | OP45 | 99 | 67 |
| P. maximowiczii x P. plantierensis | " | OP52 | 98 | 38 |
| P. charowiensis x P. balsamifera virginiana | " | OP14 | 80 | 13 |
| P. charkowiensis x P. trichocarpa | " | OP28 | 96 | 96 |
| P. nigra x P. laurifolia | " | OP 4 | 97 | 85 |
| P. maximowiczii x P. trichocarpa | " | OP42 | 92 | 56 |
| P. charkowiensis x balsamifera virginiana | " | OP16 | 78 | 69 |
| P. charkowiensis x P. caudina | " | OP20 | 74 | 24 |
| P. maximowiczii x P. plantierensis | " | OP51 | 99 | 90 |
| P. maximowiczii x P. trichocarpa | " | OP41 | 95 | 73 |
| Populus alba | Seedlings | | 100 | 98 |
| Salix alba var. vitellina | " | | 100 | 100 |

The data indicate that early counts of survival are not to be relied upon. At least one complete growing season must elapse before the success or failure of planted cuttings can be determined.

Loblolly versus Shortleaf Pine. Loblolly pine is generally recognized as a faster growing tree than shortleaf pine. The two species, however, usually occur on different sites, loblolly on fair to good sites and shortleaf on poor to fair sites, and the difference in growth rates is commonly ascribed to site instead of inherent characteristics of the species.

Reynolds reports a recent growth study of shortleaf and loblolly pine, growing side by side on the same site in southern Arkansas, which eliminates most if not all of this difference in site class and permits a more accurate comparison of growth of the two species on the same site.

The weighted average five-year diameter growth (inside bark) of 202 loblolly pine trees 13 inches and above in diameter was 1.04 inches and the five-year diameter growth of 218 shortleaf pines of the same size classes was .71 inches. Thus, the loblolly has a growth rate approximately 46 percent greater than the shortleaf. This relationship may not hold true for other regions or for other site classes but for this particular locality loblolly is certainly to be favored over the shortleaf. In cases where there is a choice between reserving either one or the other of the two species in marking for selective cutting the shortleaf tree must be of considerably better grade than the loblolly before it will pay financially to save the shortleaf.

## Southwestern

Douglas-fir. In connection with the preparation of a thoroughgoing problem analysis and work plan for Forest Management studies in the southwestern Douglas-fir type, Hermann Krauch, is now visiting the California, Pacific Northwest, Northern Rocky Mountain, and Rocky Mountain Stations to obtain first-hand information and the experience of those stations with regard to objectives, problems, and methods of meeting them, of the Douglas-fir type in those regions. Following this, he will make a trip to all national forests in Region 3 having substantial amounts of the type, to obtain up-to-date information on local problems and timber-cutting practices, and to supply information he is collecting in the other regions.

## Washington Office

A radio weather robot developed by the National Bureau of Standards with the cooperation of the Naval Bureau of Aeronautics

has undergone a successful two months' test at the Naval Air Station at Acacostia. With this robot automatic weather-observing stations, untouched by human hands for months at a time may be established on mountain peaks and other inaccessible places. Radio signals are sent out by the robot at pre-determined intervals giving the barometric pressure, air temperature, relative humidity, wind direction and velocity, rainfall, and other meteorological factors. Any standard set can receive these signals even through severe static interference, since an operator, with a stop watch, will only have to count the number of signals received in a given time. Automatic recording receivers may be used in some cases.

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## FOREST PRODUCTS

### FOREST PRODUCTS STATISTICS

#### California

Lumber Census. The preliminary statement covering production of lumber and other timber products for 1939 was issued August 15. It included reports from 254 sawmill operations cutting 50 M feet or more during the year, and showed a production of 1,687,999 M feet, the second largest annual production since 1929, and an increase of 15.46 percent over 1938. In addition to the above, 37 small mills producing less than 50 M feet reported a total cut of 891 M feet. Of the principal species, ponderosa pine represented 49.6 percent, redwood 20.3 percent, and sugar pine 14.8 percent of the total cut. As compared with 1938 there was an increase of 22.4 percent in the cut of ponderosa pine, 8.45 percent in redwood, and 19.7 percent in the cut of sugar pine.

The production of lath decreased one-third and the production of shingles increased about one-third compared with the previous year. There was a considerable decrease in the production of split products as compared with 1937.

#### Northern Rocky Mountain

Lumber Census. Editing of the last few schedules from operators in Region 1 was completed in the latter part of June and a preliminary statement for Idaho and Montana was released on August 15.

Preliminary 1939 production figures are as follows:

Lumber cut by species, M feet b.m.
(Mills cutting less than 50 M during year excluded)

| Kind of wood | Idaho | Montana | Combined cut | |
|---|---|---|---|---|
| | | | Volume | Percent |
| Idaho white pine | 365,540 | 29,989 | 395,529 | 41.8 |
| Ponderosa pine | 200,266 | 129,277 | 329,543 | 34.8 |
| Douglas-fir | 52,769 | 39,170 | 91,939 | 9.7 |
| Western larch | 24,619 | 63,698 | 88,317 | 9.4 |
| White fir | 16,025 | 73 | 16,098 | 1.7 |
| Spruce | 5,993 | 5,447 | 11,440 | 1.2 |
| Cedar | 6,241 | 103 | 6,344 | 0.7 |
| Lodgepole pine | 2,080 | 2,202 | 4,282 | 0.5 |
| Hemlock | 1,979 | - | 1,979 | 0.2 |
| All other | 77 | 33 | 1/ 110 | - |
| Total | 675,589 | 269,992 | 945,581 | 100.0 |
| Lath, M. pieces | 37,382 | 12,530 | 49,912 | |
| Shingles, squares | 36,826 | 9,710 | 46,536 | |

1/ Includes 91 M feet cottonwood, 15 M feet birch, and 4 M feet ash lumber.

In addition to the output by mills cutting 50 M feet and upward, 68 mills in Idaho and 93 Montana mills reported production amounting to less than 50 M each in 1939. The aggregate additional production reported by these very small mills, not covered by the above cut figures, amounted to 1,707 M for Idaho and 1,917 M for Montana.

In 1939, the total lumber cut by mills producing 50 M feet or over showed an increase of 19.4 percent over the combined cut of these two states in 1938.

Wholesale Lumber Prices. The latest lumber prices (August 1940) compiled by the Division of Forest Products appear below, as well as some previous prices which are presented for comparison. The prices shown for August are lower than current prices. Prices as well as production slumped during August but with the coming of September and the impetus of buying orders having their origin in the preparedness program, prices advanced. The effect of the preparedness program in advancing lumber prices will be shown in the next bi-monthly report.

Wholesale lumber selling prices
(Northeastern Washington, Idaho, Montana)

| | Annual 1939 | April-June 1940 | August 1940 |
|---|---|---|---|
| Idaho white pine | $ 30.36 | $ 33.07 | $ 31.94 |
| Ponderosa pine | 24.32 | 26.47 | 25.98 |
| Larch and Douglas-fir | 18.93 | 21.35 | 20.15 |
| White fir | 15.72 | 19.56 | 17.85 |
| Engelmann spruce | 20.01 | 21.74 | 21.77 |
| Western red cedar | 24.12 | 26.51 | 24.46 |

## Pacific Northwest

Lumber Census. The 1939 log and lumber census was completed in July. According to preliminary data, the production of lumber in Oregon and Washington in 1939 amounted to 9,009,522 M feet, board measure. This is an increase of approximately 1,870,059 M feet, or 26.19 percent, over that of 1938. For the second time Oregon takes the lead over Washington by producing 519,796 M feet more lumber in 1939. For the region as a whole, Douglas-fir production amounted to 6,202,319 M and ponderosa pine to 1,878,137 M feet. Shingle production in the two states amounted to 6,163,353 squares and lath production to 304,008,000 pieces. The canvass showed that 1,244 lumber and shingle mills operated at least a portion of the year.

# SEASONING AND PHYSICAL PROPERTIES

## California

At the time Dr. M. R. Jacobs of the Commonwealth Forestry Bureau, Australia, visited this Station recently, he suggested the possibility of reducing the excessive splitting of eucalyptus poles by boring out a portion of the center. This splitting is distinct from ruptures caused by seasoning stresses and he attributes it to the large longitudinal compression stresses found in the center of the tree as oppposed to the tension stresses of the outer portions, detailed studies of which he has carried out. Following Dr. Jacobs' suggestion tests were made on short sections of two freshly cut eucalyptus trees and, while the results were by no means conclusive, they indicate that boring out of the center may have a distinct effect on end splitting of material to be used in round form.

## STRENGTH OF WOOD

### Northern Rocky Mountain

Western Larch Plywood. Last April two larch logs were sent to the Forest Products Laboratory to be made into plywood. The logs were obtained free of charge from the Anaconda Copper Mining Company and hauled free of charge to the Laboratory by the Milwaukee Railroad. Samples of the veneer and plywood were recently received in Missoula as well as a report on the suitability of larch, prepared by Don Brouse of the Forest Products Laboratory. Those who have seen the plywood and read the report are quite pleased with the results of the experiment. Considerable interest has been whetted and Rapraeger has been asked to come to Spokane under the auspices of the Hoo-Hoo Club and to Moscow, Idaho, under the auspices of a joint meeting of the Society of American Foresters and a group of lumbermen to tell about the possibilities in using larch for plywood and to show samples of the product made at the Laboratory. It is hoped that interest will be stimulated sufficiently so that a group of lumbermen will band together and study the subject further.

## TIMBER HARVESTING AND CONVERSION

### California

1939 - Fruit Growers Supply Co. Study. The air-dried portion of the lumber resulting from the mill study carried out last October in cooperation with the Fruit Growers Supply Co., Sussanville, on trees from the Blacks Mountain Experimental Forest, was graded and tallied rough and surfaced during July. Analysis of the data from the study is nearing completion.

Second-Growth Ponderosa Pine Study. In order to secure much needed information on the character and value of second-growth ponderosa pine timber as related to quality and grade of lumber produced from it, the Products Division is undertaking a study in cooperation with the Diamond Match Co. at its Stirling City, Calif., operation. Field work in selecting and marking the trees to be included in the study is now under way and the mill portion of the study will be carried out during the early part of October.

Pacific Northwest

Spruce Logs Shipped to Laboratory. Early in September six Sitka spruce logs, ranging from 37 to 67 inches in diameter and 16 feet long, were shipped to the Forest Products Laboratory for test purposes. A great deal of difficulty has been encountered in obtaining logs of the desired quality. Although the shipment scaled only 11,264 feet, at least 1-1/4 million feet of logs were inspected to obtain this quantity.

Canadian Log Embargo. On July 10 the Canadian Timber Controller banned the export of all Douglas-fir sawlogs from British Columbia to non-Empire destinations for a period of three months. At the request of the Washington Office Johnson spent several days in Seattle interviewing key men to ascertain what effect the embargo was having or might have on the logging and lumber industry of the Pacific Northwest.

In brief, the general opinion was that the ban would have no effect on either log production or log prices in the Puget Sound region, the only market for B. C. sawlogs in the States. The imports are a mere dribble in comparison with local production, amounting to only 32,302 M feet, log scale, in 1939 and 8,834 M the first six months of 1940. These logs were almost entirely of the lower grades, 2's, 3's, and peewees. During this same period Douglas-fir log inventories on Puget Sound ranged from 180,000 M to 215,000 M feet.

Because of their inability to supply the demands, British Columbia mills are diverting a considerable quantity of orders for ties and timbers destined for the United Kingdom to Puget Sound mills. In the past this market has been largely closed to Puget Sound operators except for clears which B. C. mills were unable to supply.

Presumably the embargo expires October 10, but the Controller is expected to extend it by 30-day periods as long as the emergency exists.

Airplane Spruce Production. During July seven concerns manufacturing spruce lumber and five associations and log-grading bureaus were interviewed concerning the manufacture and use of Sitka spruce for airplanes.

In general not to exceed one-half of one percent of the spruce lumber being cut would now meet the U. S. Government specifications. Certain mills, however, get as much as 2.5 percent airplane stock.

The United Kingdom has been absorbing the greater portion of available airplane stock. The fact that their specifications are not so rigid as those of the United States and that they purchase the material as cants which will cut out a certain amount of specified grades makes it difficult for local airplane manufacturers to get high-grade material, even at prices exceeding those paid by the British.

Ponderosa Pine - Ellingson Study. Field work on a study in a pine mill at Keno, Ore., was started early in July, the lumber being followed through to the yard. The mill chosen, that of the Ellingson Lumber Co., is typical of the 50-M capacity mills in southern Oregon. It is catering principally to the box market, but is sawing so as to segregate all the moulding & btr., #1 shop, and #2 shop. The low shop grades and all of the common are cut and sold as box, usually as 6/4 stock. Other thicknesses, 4/4 and 5/4, are cut only in opening up the faces and in getting "back on the run" after turning. The study was made in cooperation with the O. and C. Land Grant Administration, and was designed to provide additional information (a) on lumber-grade recoveries and degrade between green chain and car door in mills of this type, (b) on lumber-grade recoveries from sugar pine in southern Oregon, (c) on the effect of defect on lumber recoveries, and (d) to provide another comparison between the R-6 log grades and the proposed interregional grades. It is believed that all the objectives were met, but final analysis must await the results of the dry tally.

Oversize Sawing in Ponderosa Pine. One reason for the differences noted in overrun in ponderosa pine mills is the proportion of thicknesses produced; another is the differences in the allowances for shrinkage and surfacing. The pertinent data are presented in the table. The following conclusions are evident:

1. Shrinkage and surfacing allowances for the different thicknesses of lumber vary considerably between mills.

2. Provided 4/4 stock is not given an undue allowance, 5/4 and 6/4 lumber require more wood volume per board foot of lumber as sold; therefore the greater the proportion of these thicknesses produced the lower the overrun.

Table.1.--Comparison of saw kerfs and thicknesses cut in ponderosa pine mills (all thickness in thirty-seconds of an inch)

| Mill | Thickness cut for nominal thickness of -- | | | | Saw kerf | Proportionate amount of wood (including saw kerf) necessary to produce 1 bd.ft. of lumber | | | | Proportionate amount of wood (incl. saw kerf) necessary to produce 1 bd.ft. of 4/4 lumber |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4/4 | 5/4 | 6/4 | 8/4 | | 4/4 | 5/4 | 6/4 | 8/4 | |
| A | 32 | 46 | 54 | 68 | 6 | 1.00 | 1.095 | 1.053 | .974 | 1.000 |
| B | 37 | 51 | 59 | 74 | 6 | 1.00 | 1.060 | 1.007 | .930 | 1.132 |
| C | 34 | 46 | 54 | 68 | 5 | 1.00 | 1.046 | 1.008 | .936 | 1.026 |
| D | 40 | 49 | 58 | 78 | 5 | 1.00 | .960 | .933 | .922 | 1.184 |
| E | 36 | 46 | 54 | 70 | 5 | 1.00 | .995 | .959 | .915 | 1.079 |
| F | 34 | 46 | 54 | 68 | 5 | 1.00 | 1.046 | 1.008 | .936 | 1.026 |
| G | 32 | 46 | 54 | 68 | 6 | 1.00 | 1.095 | 1.095 | .974 | 1.000 |

Douglas-fir. The demand for production studies in Douglas-fir mills has been increasing for several years; requests for the type of data resulting from such studies have been made by industry as well as by forest administrations. Negotiations are now under way for a study to be conducted in November in a Willamette Valley mill cutting representative Cascade timber. It is expected that this study will be cooperative with the Company, the Experiment Station, the Division of State and Private Forestry of the Regional Forester's Office, the O. and C. Land Grant Administration, and the West Coast Lumbermen's Association.

## WOOD PRESERVATION

### Northern Rocky Mountain

The 1940 inspection of service test ties in the Northern Pacific test track near Thompson Falls, Montana, was made by Whitney on June 25. Two officials of the railway company participated in this inspection. The creosoted Douglas-fir, white fir, ponderosa pine, lodge-pole pine, and western larch ties in this cooperative test track was laid in October 1915. In order that mechanical wear as well as decay resistance under varying conditions of service could be studied, some groups of each species were placed on a 2-degree curve, other groups on a 1-degree curve and some white fir and ponderosa pine ties in several hundred feet of tangent between a reverse curve of 1-degree and 2-degrees curvature. Total renewals, comparative renewals, and estimated average life figures for each species based on service records for the past 25 years in conjunction with the Forest Products Laboratory's tie-life curve, are shown by the following summary:

| Species | 2-degree curve | | | | 1-degree curve | | | | Tangent | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total laid | Removed to date | | Est. av. life | Total laid | Removed to date | | Est. av. life | Total laid | Removed to date | | Est. av. life |
| | No. | No. | % | Yrs. | No. | No. | % | Yrs. | No. | No. | % | Yrs. |
| Douglas-fir | 138 | 101 | 73.2 | 23.3 | 243 | 138 | 56.8 | 25.2 | - | - | - | - |
| Western larch | 148 | 111 | 75.0 | 22.7 | 220 | 116 | 52.3 | 26.5 | - | - | - | - |
| Lodgepole pine | 97 | 88 | 90.7 | 20.1 | - | - | - | - | 93 | 61 | 65.6 | 21.3 |
| White fir | 98 | 79 | 80.6 | 22.3 | - | - | - | - | 98 | 42 | 42.9 | 27.7 |
| Ponderosa pine | 91 | 28 | 30.8 | 30.9 | 193 | 46 | 23.8 | 32.4 | 84 | 13 | 15.5 | 1/ |

1/ Number of renewals too small to serve as basis for reliable estimate of average life. With only 15.5 percent renewals the tie-life curve of the Forest Products Laboratory indicates that at 25 years only 68 percent of the average life of these ties has been reached.

On September 4 the Northern Pacific test track at Missoula was covered in an inspection by Whitney in company with C. L. Willcutt, superintendent of the Paradise tie-treating plant. A total of 1,800 ties, including 1,072 western hemlock and 728 ties of other species (principally western larch, Douglas-fir, true fir, and spruce) were treated with creosote-coal tar solution and placed in this track in 1910. Approximately 62 percent of the hemlock ties were hewed and 38 percent of them sawed ties. After 30 years of service only about 20 percent of the sawed and 56 percent of the hewed hemlock ties have been renewed. Including all species, only 43.6 percent of all ties originally laid in 1910 have been replaced.

Other service test inspections made by Whitney in September included a cooperative test track near Lolo, Montana, three experimental fences, and two pole lines. The records collected for these installations have not been summarized.

Southwestern

Service Life of Untreated Fence Posts. Under the utilization study phase of the Forest Management Woodland project, a survey was undertaken in 1939 of the condition of the wood posts in existing fences of known ages. Altogether, some 2,300 posts in 97 fences, varying in age from 5 to 60 years, scattered widely through 10 of the 14 counties of Arizona, were each carefully examined as to physical condition, amount of heartwood and sapwood, extent of decay, general behavior, and degree of decay hazard. Thirty-eight fences contained posts of Utah juniper; 31, of one-seed juniper; 18, of alligator juniper; 10, of Arizona and smooth cypress; and none of Rocky Mountain red cedar; the 6 principal coniferous species of the southwestern woodlands. Detailed analysis of the resulting data has now been completed and shows:

1. That the sapwood of the three native species of juniper, and of the two native species of cypress, is not durable in the true sense of the word when used as fence posts, either under the least favorable condition of decay hazard such as exists in the desert climatic zone, or in the zone which would be most favorable to decay, that is, irrigated land.

2. That the heartwood of neither species of cypress, untreated, gives a service life of reasonable length, and that therefore posts of this species, when used in permanent fences, should be given a preservative treatment.

3. That the heartwood of juniper possesses great durability and that with respect to the long service life which can be expected there is no practical difference in this regard between the three native species.

4. That juniper fence posts containing heartwood cores of 2 inches in diameter and less are either (a) not large enough to resist an over-turn force equal to a lateral pull of 100 pounds (approximately equivalent to the force to which a fence may be subjected under ordinary conditions of use) or (b) not of sufficient mass to resist factors which might lead to incipient decay.

5. That juniper fence posts with heartwood cores 3, 4, and 5 inches in diameter are strong enough, adequately decay resistant, and otherwise serviceable to provide maximum utility, after 40 years of service in the ground, equal to:

(a) 98 percent in the desert climatic zone.
(b) 85 percent in the woodland zone.
(c) 81 percent in the saw-timber zone.
(d) 75 percent on irrigated land.

6. And that for the purposes of a specification for juniper fence posts the minimum permissible diameter of the heartwood core should be:

(a) For the desert zone, 3 inches at the ground line or $3\frac{1}{2}$ inches at the butt.

(b) For the woodland zone, $3\frac{1}{2}$ inches at the ground line or 4 inches at the butt.

(c) For the saw-timber and irrigated zones, 4 inches at the ground line or $4\frac{1}{2}$ inches at the butt.

Fence Post Durability Studies. In order to confirm on a more scientific basis the results of the empirical study of the service life of untreated fence posts in the Southwest, which data meanwhile are believed to be of sufficient accuracy for practical use by specifiers and consumers of wood fence posts, a more basic study of fence post durability was started in 1939, consisting of the installation in the various types of decay hazard existing in the Southwest of a series of test fences containing posts of practically all woodland species, untreated and some treated by the Forest Products Laboratory and locally by the tire-tube method, with the posts arranged in the fences in accordance with good statistical design. These installations have now been completed and comprise about 11 separate fences containing a total of about 700 posts in 9 different locations and involving 4 types of decay hazard ranging from the least in the dry semidesert zone to the highest in the hot irrigated lands of the desert. Periodic examinations of individual posts will be made as needed throughout the life of the experiment.

## FOREST AND RANGE INFLUENCES

### FLOOD CONTROL SURVEYS

#### Allegheny and Northeastern

General. Flood control activities in the northeastern region have been placed completely under the supervision of the Allegheny Forest Experiment Station.

The policy authorizing advance or reconnaissance investigations in flooded areas outside watersheds, in which work is now being conducted, made possible a field survey of the flooded areas in southern New Jersey following the severe storm of September 1, 1940. In spite of rainfall up to 8 or 10 inches in as many hours, no severe erosion of agricultural lands was noted, except on slopes that had been recently plowed. The principal damage apparently resulted from failure of storage dams and inadequate channel capacities of highways, culverts, and bridges.

Problems involved in determining the value of timber benefits resulting from forestry measures which are a part of a land-use program were discussed at staff meeting of the Allegheny Forest Experiment Station, September 16, 1940.

Resolutions were adopted at a recent meeting of Central New England Drainage Basin Committee in Boston, Mass., which are of importance to Flood Control Survey work. In brief, the urgent need for flood control in northeastern streams was recognized, as was the fact that water conservation measures will also improve water power, lessen pollution, and benefit recreation and wildlife. To get the maximum distribution of benefits to the region, it was resolved that an integrated program covering activities of all agencies is needed on a benefit cost ratio basis.

Through interchange of correspondence and by conferences between the members of the survey parties in the Northeast, the coordination of the procedures and methods for the various types of work has been greatly improved.

Several reports are now in different stages of editing and review previous to their submission to Washington. These reports include the Pequest, Turtle Creek, Preliminary Examinations and Youghiogheny, Merrimack Surveys. The Codorus and Buffalo Survey Reports have been submitted to Washington.

#### Preliminary Examinations

Activity in Preliminary Examinations has been confined to the Juniata Watershed, which is about 55 percent forested.

The Allegheny Survey has been classes as an intensive preliminary examination, whose objective is to determine the priority areas for the detail survey. Changes in personnel have caused serious handicaps in this investigation. Consideration will be given to changes in survey policies made necessary by the recent approval of U. S. Engineers' Conemaugh Dam on the Kiskiminitas River, which will materially reduce flood damages in Pittsburgh and other downstream points.

Connecticut. The supplement to the work outline of the Connecticut Survey covering work proposed for the present fiscal year was approved by the Flood Control Administrative Sub-Committee in Washington. The supplement outlines work for the completion of the watershed area above Brattleboro, Vermont, and the preparation of a survey report for this area this fiscal year. If funds are available after this fiscal year, the final report will be deferred, and the survey will be extended to include the whole watershed.

Upper Susquehanna. The correlation of snow survey procedure on the Upper Susquehanna, Allegheny, and Connecticut field offices has been accomplished through the activities of Harold Mitchell, Acting Senior Representative of Susquehanna Survey. Infiltration studies, hydrologic studies on small watersheds, forest yield studies are under way and progressing.

Appalachian

During August 1940 the southeastern United States experienced two storms of outstanding proportions with resultant floods of unprecedented magnitude on many streams.

Storm of August 11-17, 1940. The first of the two storms resulted from a tropical hurricane coming inland from the Atlantic at Charleston, S. C., on August 11. From Charleston it moved northwest across northern Georgia into western North Carolina and eastern Tennessee and then swung eastward across southern Virginia and moved out to sea about August 17.

Four-day rainfall at many points within the storm path amounted to 12 to 17 inches, with one-day rainfall of 6 to almost 12 inches and hourly rates of as much as two inches. The heaviest rainfall apparently occurred along the summit and eastern slopes of the Blue Ridge Mountains from central North Carolina to southern Virginia.

The heavy and intense rainfall during this storm caused severe floods on many streams, resulting in much human suffering, loss of life and property damage. Of the major streams the Roanoke River experienced probably the largest flood throughout its length, reaching

a crest stage of 58 feet at Weldon, N. C., exceeding the previously recorded maximum stage, that of November 1877, by 6.4 feet. This condition apparently resulted from the movement of the storm from the headwaters to the mouth, whereas on other major streams the storm center passed only across the headwaters. Unofficial information indicates that this flood on the headwaters of the Santee and Pee Dee Rivers, and on the Watauga and Chowan Rivers, exceeded all previous recorded flood heights, while on the French Broad, Little Tennessee and James Rivers it was somewhat below previous records.

Accompanying the flood in some areas, particularly in Watauga County, N. C., were devastating landslides or mud and debris flows, which added to the destruction by the flood waters.

Storm of August 29-30, 1940. The second storm was of the frontal type and much more restricted in area than the previous one. The area principally affected included the drainages of the Pigeon, French Broad, and Little Tennessee Rivers in western North Carolina.

During this storm two-day rainfall of from 5 to 8 inches was reported for numerous stations. At the summit of Mt. Mitchell (6,684 feet) the two-day rainfall was 12.19 inches. One-day rainfall of 4 to 7 inches was recorded at many stations, with 9.83 inches recorded at Mt. Mitchell on August 29.

Flood stages on the streams in the affected area were higher than those caused by the storm of August 11-17. The Tuckasegee River, tributary of the Little Tennessee, and the Pigeon River and Hominy Creek, tributaries of the French Broad River, experienced much damage as a result of this flood.

Preliminary Examinations and Advance Studies.

During August and September preliminary examination reports for the Little Kanawha River watershed in West Virginia and the Big Sandy River watershed in Virginia, West Virginia, and Kentucky were completed and transmitted to Washington.

Work was continued on the preliminary examination of the Roanoke River watershed in Virginia and North Carolina. The Station also cooperated in conducting a preliminary examination of the Neuse River watershed in North Carolina.

Since the floods of August were of such magnitude and low frequency the field requested that certain fundamental flood data be gathered on all watersheds affected, regardless of whether or not any flood control work was currently in progress. A request was made of Washington for authorization to do this work and for funds for accomplishing it, but to date no authorization has been granted.

Watershed Surveys

The flood control survey on the Potomac River watershed has reached the stage where a large amount of basic data has been obtained and certain analyses and remedial programs considered. The final remedial plans will shortly be formulated and the writing of the report undertaken.

Survey work on the Pee Dee River watershed, in which the Station is cooperating, received a set-back as a result of the August flood. The Yadkin, tributary of the Pee Dee, was severely affected by this flood and it became necessary to do extensive additional field work and analysis as a result of the new data becoming available. To cover the emergency situation and obtain as quickly as possible the important data required, personnel was detailed or transferred from the Potomac Survey.

Working Conference on Infiltrometer Surveys. From July 22 to August 3 the Appalachian Station was host to flood control technicians of the Department of Agriculture attending the working conference on infiltrometer surveys.

Part I of the conference began July 22 and lasted through July 30. The purpose of this phase of the conference was to train flood control technicians in the operation of the two types of infiltrometers adapted for use in flood control work. About 23 operators from flood control surveys throughout the United States attended this part of the conference. These men worked and were quartered at the Bent Creek Experimental Forest. Under the general direction of G. W. Musgrave of the Soil Conservation Service and Charles Diebold of the Forest Service, the trainees operated the F type and FA type infiltrometers and were instructed in the assembly and compilation of infiltrometer data.

For comparison between the results obtained by the infiltrometers and those obtained by analysis of the stream hydrograph, the infiltrometers were operated on two small watersheds for which the Station has rainfall and run-off records available for a number of years. The watersheds used were a forested one of about 17.3 acres and an over-grazed and depleted pasture of about 10.8 acres.

Part II of the conference began July 31 and lasted through August 3. Attending this phase of the conference, in addition to the 23 operators, were the Departmental Consultants on hydrology, L. K. Sherman, R. E. Horton, and W. W. Horner; E. J. Utz, H. L. Cook, R. A. Hertzler, R. L. Stevens, and I. H. Sims, and about 40 regional hydrologists, survey hydrologists, and other flood control personnel, together with a few visitors and C. R. Hursh and E. F. Brater from the Station.

Meetings during the second part of the conference were held in the Federal Building in Asheville.

Mr. E. J. Utz, in charge of flood control activities in the Office of Land Use Coordination, gave a brief talk outlining the broader objectives of flood control surveys and the expected contribution of infiltrometer data.

Mr. R. L. Stevens, of the hydrologic sub-committee in Washington, next presented the thought that the flood control programs of the Department will be based primarily on watershed treatment and supplemented by measures designed for flood control per se. He also stressed the need on flood control surveys for proper and adequate land-use classification from both the physical and economical standpoints.

A paper by H. G. Wilm of the Rocky Mountain Station was presented in Mr. Wilm's absence by Dr. Charles Diebold. This paper dealt with sampling methods for use in infiltrometer surveys. It was developed that in the statistical design of an infiltrometer survey, the principal soil and cover conditions should be selected and the effect of seasons taken into consideration.

The application of analysis of variance to the infiltration studies was illustrated. The application of statistical methods to the Cherry Creek watershed was also presented, including the use of covariance analysis and multiple regression. Much controversial discussion concerning the use of statistical methods of sampling in infiltrometer surveys followed the presentation of this paper.

Mr. G. W. Musgrave presented a paper on infiltration measurements in the Little Tallahatchie watershed. The paper presented the results of a series of infiltration measurements made on 4 outstanding strata in the Tallahatchie River basin.

Measurements were made by both type F and type FA infiltrometers.

Detailed results of this study were presented in tabular form, summarized as follows:

1. The results show that there is considerable variability between replicates, and that the variability was wider under well vegetated cover than under bare land conditions.

2. When 16 replicates of the FA type and 4 of the F type equipment were used, both sets of measurements showed significantly greater infiltration under a pine stand than on a bare site.

3. No significant difference was found between the two soil groups studied.

4. These data indicate that approximately 8 type F replicates, or twice as many type FA replicates may be expected to give a standard error not exceeding 0.10 inch per hour.

5. Greatly increased efficiency was obtained by using a factorial design of experiment in which the treatments were classifiable in two directions.

6. Composite curves of the rate of run-off and rate of infiltration were characteristic of the cover conditions studied. The rate of run-off on the rising side of the hydrograph as well as on the recession side was much more gradual for the pine site than on the bare areas. Likewise, the infiltration curves reached their minimum $F_c$ values much more slowly on the pine site than did the curves from the bare area.

Dr. R. E. Horton, Consultant for the Department, presented the infiltration theory of run-off, which was discussed by Messrs. W. W. Horner and L. K. Sherman, also Consultants.

Horton's discussion presented the analysis of the hydrograph in much the same manner as presented in his Publication 101. Horton discussed the division of the hydrograph into its component parts and the relations by which the hydrograph may be synthesized from rainfall data, or by which any missing component of the rainfall -- run-off relation, such as infiltration capacity, may be determined. He discussed his conception of the laws governing overland flow, surface detention, and infiltration. Horton's presentation served as a background for papers on the application of the infiltration theory.

Horner described his methods of correlating infiltrometer data with data from hydrographs obtained on small watersheds, and the application of these data to larger watersheds.

Mr. H. L. Cook, technical advisor on hydrology in the Office of Land Use Coordination, outlined the proposed organization for providing hydrologic facilities in Washington, stating that the organization was incomplete but that he expected it to develop into a source of material help to the field.

Mr. L. K. Sherman presented the application of infiltrometer data to the evaluation of flood control measures on the Little Tallahatchie River basin. He described step by step his procedure in applying infiltrometer and rainfall data, by means of the unit hydrograph, to determination of the run-off from both present and proposed improved land-use conditions, and the reduction in flood stages resulting from land-use improvements. Sherman mentioned flood frequency curves and the lack of data from which they could be determined for the Little Tallahatchie. One important point was that the same unit

hydrograph can be used for different cover conditions without materially detracting from the accuracy of the crest run-off determinations.

Dr. Hursh, of the Appalachian Station, presented infiltration data obtained on plots and watersheds of the Bent Creek Experimental Forest. Dr. Hursh outlined how the early run-off studies at Bent Creek were started by using troughs on slope plots 10' x 20', surrounded on three sides by 12-inch steel borders driven 8 inches into the ground and how in the evolution of experimental technique this early equipment was displaced first by 8' x 8' plots of undisturbed soil surrounded on three sides by concrete walls of considerable depth and equipped with automatic devices for measuring rainfall and run-off, and next by small gaged watersheds where continuous records of rainfall and run-off are obtained from natural drainage units. It was brought out in Dr. Hursh's discussion that the infiltration rates as determined from the early 8' x 8' plots were very close to those determined for similar areas by the infiltrometer studies made during the conference.

Dr. E. F. Brater, Instructor at the University of Michigan, and temporarily employed by the Station, talked on the analysis of a streamflow hydrograph. Dr. Brater used as an example a storm hydrograph from Bent Creek watershed No. 3 (over-grazed, depleted pasture) for April 19, 1940:

"This is one of the most interesting storms we have had and it seems to fit into the picture of this conference for two reasons. In the first place, it came after about 11 hours of continuous rainfall which gave a condition which simulates that which occurs during an infiltrometer run. Secondly, the watershed is the one upon which you have made a number of infiltrometer tests during the past week.

"The total precipitation was 3.75 inches. The rain began at 4 o'clock a.m. and continued until 4:40 p.m. The first 2.75 inches of precipitation produced only 0.1 inch of run-off. However, the final inch of rain which occurred between 3:20 and 4:40 p.m. produced 0.9 inch of run-off. It follows that during the first 11 hours and 20 minutes the infiltration rates were very nearly equal to the rainfall rates. These rates varied from about 0.02 to 1.05 inches per hour. However, the maximum average rate during the final one hour and 20 minutes was $\frac{.10}{1.33} = .075$ inches per hour.

"The mass diagram of infiltration was constructed on the basis of the following equation: $P_m - Q_m - S = I_m$

$P_m$ = Mass precipitation at any time.

$Q_m$ = Mass run-off at any time.

$I_m$ = Mass infiltration at any time.

S = Channel storage present at any time.

"These computations indicated that the infiltration rates actually remained fairly high during the beginning of the final hour and 20 minutes and then actually dropped to zero."

Mr. G. W. Musgrave presented the organization and management of an infiltrometer survey. Musgrave stressed the point that a successful infiltration survey depends not only on good technique but also on well formulated plans. A desirable plan should cover at least the following broad general headings:

1. Analysis of the problem.

2. Analysis of facilities available for doing the work as compared to necessities of the field survey for the results.

3. Estimation of the number of tests that can be done per month, per season, and per year when the results are completely calculated and plotted.

4. Organization of service of supplies.

5. Prepare a plan of operation which plan will be most efficient if based on a factorial design.

6. Final examination of the complete plan to check its completeness and to systematize and coordinate each phase of work.

Several actual plans of operation being used by different surveys were presented and the relative merits of the plans were discussed.

Mr. R. A. Hertzler presented the preparation of infiltrometer survey reports, in which he developed the manner in which data should be compiled. Discussion followed on how rainfall and infiltration data would be presented in tabular and graph form, the types and number of curves desired, and other such matters.

The conference was concluded on the afternoon of August 3 by the presentation of committee reports prepared by the operating technicians and by a summary of the conference accomplishments by G. W. Musgrave.

The afternoon of July 31 was spent in observing a field demonstration of the operation of F and FA type infiltrometer equipment. At the conclusion of the field inspection a picnic supper at Bent Creek was provided.

After the regular conference sessions on August 3 a field trip to the Coweeta Experimental Forest was arranged. A considerable

number of conferees took advantage of this trip to see more of the Forest Influence Research being done by the Station.

## California

### Preliminary Examinations

During the period preliminary examination reports have been completed for the Walker River drainage of about 4,000 square miles in California and Nevada and the Santa Ynez River of about 900 square miles in California. The report on the Santa Clara River has been deferred pending the completion of additional hydrologic studies to determine more closely the effect of upstream protection measures. Work has continued on cover type and fire history maps for various other streams in California including the Russian, Eel, and Mad Rivers and the San Diego Group. Field examinations have been completed for the Carson and Truckee River basins.

### Watershed Surveys

San Gabriel, Santa Ana, Pajaro, and Santa Maria Rivers. The draft of the San Gabriel report is nearing completion and is expected to be in the hands of the Field Coordinating Committee in the near future for review before assembly of the final text.

During the period field work has begun on the Santa Ana Survey and preliminary steps were taken for the organization of the Santa Maria Survey. Most of the personnel of the San Gabriel Survey have moved to the Santa Ana Survey, where headquarters were opened at Riverside on October 1.

The Pajaro report is expected to be completed about November 30, 1940, but since the U. S. Engineers have deferred their report on this stream to accumulate necessary hydrologic records, the Department of Agriculture report will not be correlated with any plans of the U. S. Engineers. The Pajaro report will therefore present recommendations for remedial measures in two very localized areas of the watershed and will make recommendations for over-all improvement in land-use management which are not strictly within the province of flood control.

The personnel of the Pajaro Survey will be transferred to the Santa Maria Survey about October 15.

## Central States

Muskingum River Detailed Survey. The Raccoon Creek unit report has been accepted by the Field Coordinating Committee and

submitted to Washington. Review by the Working Committee of the first draft of the main report has been completed and the final report is being mimeographed and assembled.

Wabash River Intensified Preliminary Examination. Because of poor road conditions on the Cumberland River watershed during the winter months, the personnel of all three agencies has been concentrating on the Cumberland P. E. Infiltration studies with the Type F equipment will be confined to the Miami Crosby series, which is the most important soil type in the watershed. Eight replications each will be run on corn, good and poor pasture, and good and poor woodland, a total of 40 runs.

Cumberland Preliminary Examination. This examination has been advanced in priority at the request of the Cumberland River Drainage Basin Committee to facilitate its preparation of an over-all plan for the river similar to that prepared for the Red River of the North. Field work is advancing steadily with the objective of completing it as far as possible before December 1. Reconnaissance indicates that most of the flood damage will be found on the tributary streams. The main river is so deeply entrenched over much of its course that little first bottom exists.

Little Sioux River Detailed Survey. Except for the bluff lands along the Missouri River most of this watershed is in prairie. Improved woodland management and some reforestation will be needed in these bluff areas. It is doubtful if much benefit can be derived through any agricultural program on the almost level prairie soils in the upper reaches of the river. Richman, of the Forest Service, is in charge of the infiltration work in addition to his forestry studies.

Meramec River Preliminary Examination. Field work on the examination will be completed in October and the report should be ready for submission to Washington by December 1. Very effective cooperation on the examination has been secured from the Missouri State Planning Board. Although the SCS holds chairmanship on this watershed the major responsibilities for the preparation of the report have rested with this Station. The Meramec is a heavily timbered watershed and contains portions of both the Clark and Mark Twain National Forests.

Intermountain

Sevier Lake Watershed Survey. With the threat of snow on the mountainous flood contributing portions of the Sevier Lake watershed becoming more imminent each day, the Sevier Survey is rapidly completing all planned field work for this season with a few toward the analysis of these data during the winter months. The field work on

damage appraisal, flood source area classification, and the preliminary phases of remedial programs has been largely completed on a number of sample tributaries. Further field work on sedimentation damage is planned for the winter months while additional infiltration tests as well as further checks on flood source area classification and on the applicability of remedial measures are planned for next spring.

Hydrological investigations, though as yet incomplete, already have thrown considerable light on the extent to which watershed improvement measures may be expected to minimize surface run-off during torrential summer storms. For example, infiltrometer tests on herbaceous range areas show that infiltration rates are 4.0 and 3.2 inches per hour for dry and wet runs, respectively, on well covered (low-flood source) areas and only 0.56 and 0.54 inches per hour for dry and wet runs, respectively, on poorly covered (high-flood source) areas, thus indicating the possibility of a material reduction in surface run-off through the restoration of the plant and soil mantle on "sore spots".

A further analysis of the data from the A-B experimental watersheds at the Great Basin Branch Station by Horton's method confirms the results reported in USDA Technical Bulletin 220 and also is presenting these data in a form that will be more useful for evaluating the effects of a remedial program. Following is a summary of the average infiltration rates and the Area A/Area B ratios during three periods when significantly different plant and soil mantle conditions prevailed on the watersheds:

| Period | Number of storms | Average infiltration (Rates (F. av.)) Area A (In./hr.) | Area B (In./hr.) | Area A - Area B ratios |
|---|---|---|---|---|
| 1/1 | 5 | 0.813 | 1.428 | 1.756 |
| 2/2 | 10 | 1.170 | 1.430 | 1.222 |
| 3/3 | 17 | 0.981 | 1.097 | 1.118 |

1/ (1919-1923) - Plant cover density on Area A was 16 percent; 40 percent on Area B. (Lack of rainfall intensity records 1914-1918 precluded analysis of storms and run-off in that period.)

2/ (1924-1935) - Plant cover density on both areas approximately 40 percent.

3/ (1936-1938) - Plant cover density on Area A was 40 percent; about 25 percent on Area B. (No run-off producing storms in 1939 and records not yet available for 1940. Density on Area B to be reduced to 16 percent so as to be comparable to Area A at start of experiment.)

These data show that the average infiltration rate of Area B remained essentially constant as long as there was no change in the plant and soil mantle but that a reduction in the plant cover density as well as disturbance of the soil in recent years has been accompanied by about a 25-percent reduction in the infiltration rate. Conversely, an improvement in the plant and soil mantle on Area A has resulted in a significant increase in the average infiltration rate. Since this analysis does not include data covering the earliest period of the experiment when Area A was in seriously deteriorated condition nor for the last two years during which there has been further reduction in the density of the plant cover on Area B, it may be inferred that much greater differences in the A/B ratios actually have taken place than is indicated in the current data.

Further analyses of the A-B experimental watershed data which are now under way include: correlations with infiltrometer data, soil moisture data, and rainfall characteristics.

The paucity of hydro-meteorological data within the Sevier Lake watershed has revealed a pressing need for answers to a number of questions concerning the characteristics of flood-producing torrential summer storms. These questions have been submitted to the F.C.A.C. with a request that they be considered by the Hydro-Meteorological Section of the U. S. Weather Bureau.

Lake States

Field work on the Whitewater survey has been largely completed. Precipitation and streamflow records are still being taken so that if any floods occur, the data can be used to strengthen those already collected.

The infiltration survey which was conducted under Forest Service supervision was stopped in August. A special report covering this phase was recently submitted to Washington. An apparatus designed by Bates was used, as the North Fork infiltrometer gives incorrect results on the bare soils of this region, and the new equipment was not available when the survey was started.

Pacific Northwest

Walla Walla Survey. The "soils-plant cover" phase of the survey was handled by the Forest Service and field work was completed in mid-September. Field work in connection with the engineering and flood damage phases of the survey is also practically finished and preparations have been made to complete the infiltration tests.

Preliminary Examination Reports. The Willow Creek and Umatilla reports are in the final stages. A report on streams in the Tillamook Bay Region has been prepared in rough draft and will soon be sent to the BAE and SCS for comment.

Water Regimen Subcommittee. At the spring meeting of the Pacific Northwest Drainage Basin Committee there was suggested the formation of a subcommittee to study water regimen. Wyckoff is the Forest Service member on this subcommittee. At the first meeting of the various agencies interested in this subject it was agreed that each should submit a statement covering their activities and facilities related to water. This would include regional organization, bibliography of published and unpublished material, very brief description of studies now being conducted, and maps showing location of meteorological and hydrological stations and other useful data. The Forest Service report, consisting of an inventory of existing information together with deficiencies and recommendations for remedying these, was submitted to the committee early in July. Much of Bolles's time during June was spent on this report.

Meetings. Several meetings of the field working committee were held in connection with the Walla Walla survey or for discussion of the preliminary reports. In June Chapler spent two weeks in California visiting San Dimas and other research projects and conferring with those conducting forest influences studies.

Rocky Mountain

The Flood Problem Area of the South Platte River. Studies made on the South Platte River watershed show that serious flood damage has been incurred on the main stem of the river between Waterton and Kersey, Colorado, and along its major tributaries in the upper Basin. These tributaries are Plum, Dry, Bear, Cherry, Sand, Clear, and Trout Creek, and the North Fork of the South Platte. The flood-contributing area includes 2,886 square miles, of which approximately 1,843 square miles is in the region southwest of Denver and below 8,000 feet in elevation. Flood losses are approximately $280,000 annually for the period 1912-1939, or an annual loss of $97.00 per square mile.

An analysis of the flood and sedimentation losses in 31 watersheds within the Missouri, Red, and Arkansas basins for which preliminary examinations have been made show that the South Platte watershed has probably the third most serious flood area between the Continental Divide and the Mississippi River. Only the Washita and Verdigris River watersheds appear to have more serious flood problem areas. The Washita basin has an annual damage of about $133 per square mile while a similar figure for the Verdigris is about $117.

Southwestern

Preliminary Examinations

Williams-Big Sandy PE. The preliminary examination field work and report on the Williams-Big Sandy watershed in northwestern Arizona, held in abeyance since their initiation in the spring of 1939, have again become active and it is expected that the final draft of the report will be available for critical review and approval of the Field Coordinating Committee within the next 45 days, after which it will be forwarded to the Washington Office. The work of the Corps of Engineers on this watershed has about the same status.

Gila River PE. Work is just starting on the over-all preliminary examination and report of the Gila River watershed, with particular attention to that portion lying between the San Carlos Reservoir, upstream, and the proposed Gillespie Dam of the Lower Gila Survey Project, downstream, authorized for prosecution the current fiscal year. The BAE damage work is well started.

Rio Grande Intensified PE. A detailed work outline for the intensified preliminary examination and advance studies in the Rio Grande watershed, authorized for completion by June 30, 1941, has been prepared and approved by the Field Coordinating Committee and is ready for submittal to Washington. Actual field work has not yet started.

Surveys

Queen Creek Survey Project. The revised and greatly condensed survey report, together with the more voluminous appendix, for the Queen Creek watershed was approved by the Field Coordinating Committee and submitted in July 1940 to Washington, where it awaits review and action. Significant findings and recommendations are: (a) That to meet the flood and erosion problems, a program of range-use adjustment, dikes, and minor engineering structure is required at a total cost of $687,400, with total annual expenses of $53,600, total annual benefits of $166,300, or a ratio of 3.1 to 1.0; (b) that local interests be required to participate in the program by purchase of necessary rights-of-way and easements and of privately owned range improvements on State lands, aggregating $63,400, and to assume annual maintenance costs of $15,500; (c) that the balance of the cost of the program be borne from Flood Control, WPA, and CCC funds; (d) that the construction program be carried into effect over a 2-year period; (e) and that the Soil Conservation Service be the construction agency and either that Service or the Forest Service be the subsequent administrative agency. The most troublesome problem in carrying out the action program will be to effectuate the necessary range-use adjustments on the State and private lands outside the National Forest and Indian reservations, comprising about two-thirds of the area of the watershed.

Rio Puerco Survey Project. The survey report for the Rio Puerco, an important tributary of the upper Rio Grande, is ready for submission to Washington within 10 days. Significant findings and recommendations are: (a) That the Rio Puerco presents both internal and external waterflow and soil-erosion problems of great magnitude, it having a notorious reputation throughout the Southwest; (b) that the land-use history of the watershed and surrounding ranges, beginning two or three centuries ago, has been one of misuse and abuse; (c) that silt rather than water occupies first place as a public hazard; (d) that a program be undertaken over a 50-year period, consisting of systematic land-use adjustments, minor engineering structures, and major public works in the nature of a series of 6 silt barriers and some 65 spreading weirs; (e) and that the total cost over the 50-year period (including amortization) is estimated at some $17,700,000, with total benefits some $48,600,000.

Upper Gila Survey Project. All the field work by the three bureaus on this project has been completed, except the infiltrometer work being especially done for the Gila-San Carlos special investigation. The analysis of data and preparation of report are being kept apace with the release of information by the Army on the results of its survey, final report on which is not expected before April 1, 1941. The results of the special Gila River-San Carlos Reservoir investigation will also have distinct bearing on the type of data to be presented and the recommendations to be made looking toward an action program on the upper Gila watershed. These two situations prevent maximum progress toward prompt completion of this survey report. On the other hand, the required land-purchase program and range-use adjustment plan, involving particularly National Forest land, are going forward in an effort to supply National Forest administration with information useful in formulating its 1941 grazing plans.

Lower Gila Survey Project. All field work, except certain minor rechecks, has been completed. Preparation of maps and analysis of data are three-fourths done. The report should be ready for attention of the Field Coordinating Committee about November 1.

Pecos Survey Project. Aside from a very limited amount of field work necessary to strengthen certain supporting data, the field work has been completed by all three cooperating bureaus, and the analysis of data and preparation of preliminary draft of the survey report are 75 percent completed. Some sections, such as that on timberlands, are complete. The tentative data for completion by November 30, 1940, still holds good.

## Appalachian

Reading Rain Gages. A number of requests have come to the Appalachian Station for information on the servicing of a large number of rain gages by unskilled labor. This is the way it is done on the Coweeta Forest.

To read the 72 standard rain gages on the Coweeta Experimental Forest, it is necessary to walk more than 30 miles by five different trails. To insure that this is done immediately after each storm, a crew of CCC enrollees has been organized at Camp NC F-23. A crew of ten men, in pairs for safety and check, is required to make observations as they walk each trail. In this way it is also possible to have one man of the pair who has serviced the gages before. The average enrollee at this camp has only the equivalent of a sixth grade education, so careful selection is necessary. This selection is accomplished through the cooperation of the Educational Advisor and the Project Superintendent.

The Station Staff member assigned to precipitation records takes charge of the crew when morning job assignments are made at the camp. The men are instructed as to location of trails by means of a large relief map of the Experimental Forest. After every storm each pair is assigned a trail to walk and furnished a gage stick, printed record forms, watch, and pencil. The assignments by trails are on a rotation basis because some of the trails are more difficult than others. The same pair does not service the same gage twice in succession. The gages are listed on the record forms in the order they are reached on the trails. When the reading is made the severity of the rain and the time of observation are recorded. Time is recorded as a check and to make corrections if a shower occurs when the boys are on the trails.

Field checking is done by reading some of the gages before the crew. The gage may then be emptied to determine whether or not the man will attempt to fake a reading when they meet an unusual condition, or left full to see if the men are reading the gages correctly. When each pair returns, the observations are checked by inspection and isohyetals plotted which serve as an additional check on inaccurate readings. The final check is the continuous records from the recording rain gages distributed throughout the area and serviced by a regular Staff member. At intervals, meetings are held with the crew to discuss procedures and the importance of accuracy. Very few disciplinary cases have been necessary during the past six years of operation. One of the principal causes of enrollees not wanting to service the rain gages has not been the steep long trails, but the very justifiable fear of snakes.

Effects of August Storms. The month of August brought two major storms to western North Carolina, both of them striking the Coweeta and the Bent Creek Experimental Forests where drainage area studies are in progress. The following records were taken:

STORM OF AUGUST 12-13

| | Coweeta Forest | Bent Creek Forest |
|---|---|---|
| Precipitation: | | |
| Duration | 36 hours | 40 hours |
| Range | 10.68 - 5.51 in. | 6.29 - 5.38 in. |
| Average | 7.43 " | 5.87 " |
| Intensity | (10 min.=1.20 in./hr. | 1.26 in./hr. |
| (2200 ft.elev.) | (20 min.=0.90 " | 1.23 " |
| | (60 min.=0.70 " | 0.78 " |
| Runoff: 10-80 acres: | | |
| Forested drainages | 15 - 79 c.s.m. | 40 c.s.m. |
| Cleared for plowing | 37 " | -- |
| Depleted pasture | -- | 450 " |
| Runoff: 1-3 sq. mile: | | |
| Forest and restocking old field | 49 - 104 c.s.m. | <65 " |
| Forest and agric. | -- | 72 " |

STORM OF AUGUST 29-30

| | Coweeta Forest | Bent Creek Forest |
|---|---|---|
| Precipitation: | | |
| Duration | 22 hours | 20 hours |
| Range | 7.31 - 4.64 in. | 9.21 - 8.22 in. |
| Average | 5.73 " | 8.51 " |
| Intensity | (10 min.=2.10 in./hr. | 2.70 in./hr. |
| (2200 ft.elev.) | (20 min.=1.62 " | 2.04 " |
| | (60 min.=1.30 " | 1.17 " |
| Runoff: 10-80 acres: | | |
| Forested | 22-90 c.s.m. | 108 c.s.m. |
| Cleared for plowing | 123 " | -- |
| Depleted pasture | -- | 1450 " |
| Runoff: 1-3 sq.mile: | | |
| Forest and restocking old field | 45-100 " | * 245 " |
| Forest and agric. | -- | * 375 " |

* (Estimated from high-water marks.)

A field reconnaissance of the behavior of streams outside of the Experimental Forest indicated the second storm produced flood stages in some localities the highest known for at

least 50 years. The geomorphological effects of this second storm are particularly significant. Stream channels which had been in the process of occlusion with eroded material from cultivated land and roads for a score of years or more were swept completely clean. Lookingglass River on the Pisgah Forest, which had recently been badly silted from new roadway construction, was swept clean of debris of all kinds. Fishing pools were deepened and enlarged on all the smaller streams. In addition to cleaning and deepening individual holes, the flood caused stream banks to be moved back from 3 to 10 feet wherever the soil permitted cutting. Very small streams on the Bent Creek Forest usually flowing less than 1/10 c.f.s. actually moved large boulders and logs during the peak of the flood stage.

In a few small areas shallow soils being cultivated on steep hillsides were washed away to the country rock. In a few instances, "water spouts" due to building up of hydrostatic pressure in steep talus material were reported. Slides along roadsides were common. The tremendous loads of silt and sand cleaned from the channels and carried by the streams at load stage were deposited by the receding waters on flooded bottom lands adjacent to the streams. All in all, changes in geomorphology of some localities were probably as great as will usually be seen in a normal lifetime.

Flood stages greater in the second than in the first storm are in part explained by well observations both at the Coweeta and the Bent Creek Forest. Index wells having a water table of 20 feet or more below the surface showed practically no influence from the first storm but rose sharply after ten hours after the beginning of the second storm. This and similar well records indicated that the larger proportion of the first rain was easily stored in the forested areas without bringing the soils beyond field capacity. However, the second storm found the water requirements within the zone of aeration already well satisfied with resulting percolation rates greatly lowered.

On Coweeta Forest these two storms did not produce significantly high peaks. On the Bent Creek Forest, however, it is likely that local cloud-burst conditions obtained on the headwaters of certain small tributaries for which no precipitation record is available. Estimates from field works indicated that the runoff may have approached the peak of 250 c.s.m. for a 740-acre drainage, about half of which had been once used for agriculture and is now restocking to pine and hardwoods. A small depleted pasture produced an accurately measured peak of 1445 c.s.m. to be compared with a control area of undisturbed forest which gave a peak of 108 c.s.m.

California

Watercycle and Soil Studies. During the past four months, the Bass Lake, North Fork, San Joaquin, and Berkeley field installations

have been overhauled and placed in operating order for the 1940-41 rainy season. Compilation of the data collected during the 1939-40 season will be completed next month with the assistance of our WPA statistical project.

Several new or supplementary studies were started during the summer. On the Oxford Street lysimeters at Berkeley, a study has been started to determine the effectiveness of mustard sowing in the control of surface run-off and erosion. Both natural and artificial rainfall are being employed. The artificially applied "storms" will be used chiefly to determine the effectiveness of a mustard cover in the control of surface run-off and erosion at different stages of growth.

An interception and streamflow study has been started in a 60-80-year-old stand of second-growth ponderosa pine in connection with the surface run-off and erosion installations at Bass Lake. A series of soil moisture sampling plots and snow evaporation studies similar to those at North Fork have also been established at this installation.

An infiltration study employing the North Fork infiltrometer was made on the surface run-off and erosion plots at the San Joaquin Experimental Range in cooperation with the Range Division. The purpose of the study was to determine the influence of different intensities of grazing on the infiltration capacity of the soil. Thirty-six infiltration capacity determinations were made on nine 1/40-acre plots with the following results:

| No. of plots | Experimental treatment | Soil at summer dryness | | Soil moisture at field capacity | |
|---|---|---|---|---|---|
| | | No. of tests | Infiltration capacity | No. of tests | Infiltration capacity |
| | | | (In. per hr.) | | (In. per hr.) |
| 3 | Ungrazed 5 years | 9 | 8.3 | 9 | 8.0 |
| 3 | Ungrazed 3 years Moderately grazed 2 years | 9 | 6.6 | 9 | 5.8 |
| 3 | Ungrazed 3 years Heavily grazed 2 years | 9 | 4.5 | 9 | 3.4 |

These data clearly indicate the influence of moderate or heavy grazing on the infiltration capacities of the soils sampled.

The field work on the Pajaro infiltration survey, in which members of the Influences staff acted as technical consultants, was completed during July; and at the present time the data are being

analyzed for inclusion in the Flood Control Survey report of this watershed. The results show large differences in the infiltration capacities of the soils in the several vegetative types sampled. The soils of the forest and brush areas had the highest infiltration capacities and the soils of the grass and chamise areas had the lowest infiltration capacities. Infiltration capacities are normally lower for heavily grazed than for lightly grazed or ungrazed areas. The results also indicate lower infiltration capacities on the heavier soil types, particularly those with shallow or depleted "A" horizons.

San Dimas Experimental Forest. During the past four months, activity on the San Dimas Experimental Forest has consisted of overhauling and cleaning instruments, leveling and repairing raingages, tabulating, checking, and summarizing data, and soil removal from the lysimeters. This latter operation involved considerable activity by way of preparation, such as analysis of past records from the lysimeters, and careful soil moisture sampling.

Upon completion of the San Dimas lysimeters at Tanbark Flat in 1936, they were filled with soil and exposed to the elements in 1937. The filling with soil was done with great care to insure as little variation between lysimeters as possible. At that time each of the large, unconfined, and root study lysimeters was over-filled to a depth of one foot above the final grade to allow for settlement. During the seasons 1937-38, 1938-39, and 1939-40, measurements were made of rainfall, runoff, and seepage from each lysimeter. At the end of each season, the amount of soil settlement was determined by resurvey of the soil surface in each lysimeter. The average settlement is shown in the following table.

Table 1.-Average settlement in hundredths of feet

| Type of lysimeter | 1937 | 1938 | 1939 | 1940 | Total |
|---|---|---|---|---|---|
| Large | .09 | .38 | .07 | .03 | .54 |
| Unconfined | - | .44 | - | - | .44 |
| Root study | - | - | .14 | .08 | .22 |
| Medium | - | - | - | - | .45 |
| Small | - | - | - | - | .16 |

The measurements made at the end of the 1939-40 season indicated that the rate of settlement had decreased to practical stability. This terminated the first phase of the study and it was decided that the overfill soil could be removed and the lysimeters started on the second phase. The second phase consists of establishing on the lysimeters a uniform cover of an annual grass (Bromus mollis) and allowing this to remain for several years during which measurements of seepage, rainfall, runoff, and soil moisture will be made.

The average results of measurements of rainfall, runoff, and seepage from the 26 large lysimeters during the past three years are indicated in the following table.

Table 2.-Comparative average lysimeter performance

| Season | Precip. P | Runoff R | Seepage S | Water yield R+S=Y | R % | S % (of rainfall) | Y % |
|---|---|---|---|---|---|---|---|
| | Inches | Inches | Inches | Inches | | | |
| 1937-38 | 47.03 | 26.24 | 0.43 | 26.67 | 55.8 | 0.9 | 56.7 |
| 1938-39 | 20.52 | 7.78 | 4.06 | 11.84 | 37.9 | 19.8 | 57.7 |
| 1939-40 | 26.46 | 14.80 | 1/ 3.73 | 1/ 18.53 | 55.9 | 1/ 14.1 | 1/ 70.0 |
| 3-yr. total | 94.01 | 48.82 | 1/ 8.22 | 1/ 57.04 | 52.0 | 1/ 8.7 | 1/ 60.7 |

1/ Seepage total for 1940 to July 10, inclusive

The season 1937-38 included the March 1938 storm, which produced some 22 inches of rain at high and sustained intensities. At that time the lysimeters were freshly filled and their runoff was high. The second season saw a rather low rainfall with only one storm of fairly high intensity, and the runoff was correspondingly low. Seepage occurred early and continued throughout the year. The season of 1939-40 was marked by a series of short intense storms which produced high runoff. Seepage has continued without cessation since last year.

The removal of overfill soil from the large lysimeters was carried out during September according to a carefully worked out plan involving the following steps:

1. Intensive moisture and volume-weight sampling of the overfill by 3-inch layers on lysimeter (#26).

2. Intensive moisture sampling of overfill by 2-inch layers on lysimeter #14. Table 3 shows the variation in soil moisture at different depths in the overfill soil.

Table 3.-Overfill soil moisture, lysimeter #14

| Depth | Average moisture |
|---|---|
| Inches | Percent |
| 0-2 | 4.01 |
| 2-4 | 8.32 |
| 4-6 | 9.79 |

These averages are based upon samples taken at 27 different locations over the surface of the lysimeter. This table shows the extreme dryness of the top two inches of soil.

3. Pozzo soil tube borings at six locations on lysimeters #23, 16, 8, 3, and 2. This selection provided for sampling lysimeters of average performance as well as those diverging from the average.

4. The overfill collars were removed and the soil excavated to the tops of the concrete walls. A scraper the full width of a lysimeter was then pushed over the tanks to smooth the soil surface and bring it to a uniform grade. This produced a soil block exactly 6 feet in depth. All of the soil removed was weighed before being hauled away, and an aliquot sample was taken of the overfill from each lysimeter. Moisture determinations with this sample allowed the computation of dry weight of soil removed from each lysimeter. A record has been kept of the dry weight of soil put in or removed from each lysimeter so that the amount in each lysimeter at any time is known.

The unconfined lysimeters were similarly treated. These are 17 feet square and 7 feet deep with the overfill removed. As the name implies, these have no confining walls and their boundaries have been determined by surveys from reference points. Iron border strips were placed on the upper end and the two sides of each of these to keep out surface runoff from adjacent areas. Eventually an area of 2-1/2 milacres will be marked out within the borders of each of the present squares to serve as the actual lysimeter. These plots will be equipped only with surface runoff catchment troughs and collector tanks. The balance of the large squares will serve as "buffer" areas and will be used for periodic soil tube sampling to determine moisture distribution.

Sowing of the lysimeters and surrounding border areas with soft cheat grass seed will be completed soon. Seed for this purpose was collected on the San Joaquin Experimental Range.

Intermountain

Farmington Experimental Watersheds. Progress in the development of the experimental area of the Wasatch Branch Station during the past year has included the construction of stream-gaging stations and soil moisture sampling pits, the further development of surface run-off plots, the revamping and extension of the precipitation gage network, and the completion of the field work of a plant and soil inventory on all newly gaged watersheds. These accomplishments, mainly by means of WPA funds, brings within sight the end of the developmental stage of this area.

The new stream-gaging stations include five Venturi-trapezoidal flumes and two concrete and rubble control sections equipped with stilling wells and waterstage recorders. The latter structures respresent a new development which gives promise of very satisfactory performance in stream gaging. Being constructed at natural channel gradient they are completely self-cleaning of ordinary debris and should pass extreme mud flows with little damage. A "V" section forming the floor provides for accurate measurement of low heads and the length of control is such that conditions of normal flow should be attained by the highest expected discharges.

With the completion of these installations, streamflow records are now being obtained from eleven tributaries of Farmington Creek and from the Creek itself near its mouth. Concrete and rubble approaches are now being constructed at all flumes to eliminate the effects of variable channel conditions at the flume entrance. When these are finished, intensive calibration of all gaging stations will be made.

Two soil sampling pits have been constructed, one having a north and one a south aspect, each one having facilities for making duplicate soil moisture determinations at depths of 3, 6, 9, 12, 24, 36, 48, 60, and 72 inches below the soil surface. A modification of the Bouyoucos technique employing plaster of paris blocks will be used with moisture evaluations made both electrically and by weighing. These pits will furnish the intensive basis for soil moisture studies to be carried out extensively over north and south aspects of the canyon.

The collector tanks on 16 surface run-off plots in Parrish Canyon have been doubled in size as insurance against overflow, and waterstage transmitters have been made and installed at all plots. Intensity of run-off as relayed by these transmitters and intensity of rainfall as relayed by a tipping bucket gage are recorded by the same electrical recorder and thus furnish a reliable record of time relationships between rainfall and run-off.

A new plan covering the distribution of precipitation gages has been drawn up with the purpose of extending the network over newly gaged watersheds and incorporating new ideas of locating gages where shielding is provided by suitable brush. Included in the revamped network will be 50 year-round gages to measure both rain and snow. The installation of these is now in progress. Five additional intensity gages of the weighing type are also being added to complete a pattern of nine such gages distributed by elevation and aspect over the experimental area.

During the past summer the field work of a plant and soil inventory of the newly gaged watersheds has been completed inclusive of a type map and the detailed record of plant cover and soil conditions on 380 random sample plots. With the completion of soil

analyses and compilation of data, a comprehensive record of initial conditions of vegetation and soil on all gaged watersheds will exist with which to compare future conditions in the light of contemporary changes in streamflow behavior.

Rocky Mountain

Comparison of Methods of Measuring Infiltration. Five types of infiltrometers were used in a study of infiltration methods made during the past summer on the Manitou Experimental Forest. These infiltrometers were: cylinders 4 inches in diameter in which water was applied under a head of 3 inches; the Pearse "square-foot" instrument, with water applied as a sheet; a modified North Fork infiltrometer, using Type "FA" sprinklers; an apparatus similar to the North Fork instrument, but 2 by 4 feet in size, and using three Type "FA" sprinklers; and a large infiltrometer, similar in size and equipment to the Type "F" equipment used on flood control surveys.

Rainfall was measured on all the sprinkled plots by means of rain gages hung over the plot. On the Type "F" plot, two trough rain gages were employed, parallel to the long axis of the plot and located 1/4 of the plot width away from each boundary plate. Gages 1 inch in diameter were used for the North Fork and Rocky Mountain (2 x 4 foot) plots: 6 gages on the smaller instrument, and 12 on the larger. Careful measurements show that these rain gages give records which agree reasonably well with pan records of total water applied.

A preliminary analysis of the results leads to the following tentative conclusions:

1. Of the five methods studied, three may be used almost interchangeably for measurement of infiltration rates. The square-foot and Rocky Mountain plots showed rates not differing significantly from the Type "F" equipment even when site variation was excluded from "experimental error".

2. The various methods tested require varying numbers of plots in order to provide mean infiltration rates of the same degree of reliability for any given population. If, for example, five Type "F" plots are needed to give a desired degree of reliability, seven North Fork plots will be required for the same accuracy. Eight Rocky Mountain plots, 29 square-foot plots, or 59 groups of 4 cylinders will give corresponding results.

3. Because of excessive variability and high rates of infiltration, the cylinder method should not be considered for field use.

4. The operation cost of the Type "F" equipment is so great as to exclude its use except under special conditions. Wherever the vegetation or other factor studied occurs in units small enough to be covered by the smaller plots, they should give results just as reliable as those of the large equipment.

Aside from the primary investigation, a secondary study was set up in a series of Latin squares, so that in addition to a comparison of the square-foot, Type "FA" and Rocky Mountain instruments it was possible to isolate variation due to variability in soil within a plot group. Final analysis will also include regressions of infiltration on rainfall intensity, plant cover density, soil temperature, ground slope, and the gravel content and volume weight of soil.

Southwestern

Water Yield on Steep Mountain Slopes in Central Arizona. Under natural undeteriorated conditions very little precipitation water runs directly from the surface of steep mountain slopes on the Salt River watershed in central Arizona. Practically all of the flow reaching permanent streams or reservoirs is seepage water which flows in natural water courses.

Flow from summer precipitation is almost a negligible quantity. Six years of flow measurements from the upper Parker Creek watershed, an area of 700 acres, show that less than 1 percent of summer precipitation passes over the measuring stations. This watershed has been protected from grazing use since 1932 and the herbaceous vegetation is in good condition, although open slopes still bear erosion scars resulting from heavy grazing use prior to 1932.

In winter the average yield of water during the 6-year period amounted to approximately 30 percent of the winter precipitation. From measurement of water behavior in lysimeters, run-off effects on steep slopes, and from observation of the watershed, it is known that practically all of the winter flow on upper Parker Creek comes from seepage flow rather than from run-off originating on the surface of the slopes. Some of this winter precipitation is in the form of snow, most of the remainder as gentle rainfall. Surface run-off does occur even from winter rainfall if the ground is bare or nearly so. Fortunately, at the medium to high elevations of the steep mountain country these extreme conditions are usually limited to small areas.

The findings on the experimental watershed area are corroborated by surface run-off measurements from plots located on steep mountain slopes which have a gradient of 60 percent. These measurements show an average surface run-off of about 1 percent from a fall

of 144.72 inches during the 6-year period between April 1, 1934, and March 31, 1940. This average represents readings from many storms of widely divergent character, ranging from gentle winter rains falling at a rate of 0.12 inch per hour or less to torrential summer rains with an intensity rate of as much as 4.50 inches per hour for short periods. Surface run-off varies from a zero quantity during gentle rain storms in winter to a high of 14 percent during the hardest summer rain ever recorded. This was measured on an area where the herbaceous vegetation had been closely grazed. During this same storm, when 5.02 inches of rain fell in 2-1/4 hours, only 3 percent of the precipitation ran off an ungrazed non-deteriorated area; 165 cubic feet per acre of topsoil, rock, and debris washed off deteriorated slopes, as compared to only 2 cubic feet per acre of material eroded from the non-deteriorated area. Flash flow from deteriorated areas, which are small in extent, seldom reach live stream channels and therefore contribute little to stored water supplies. The character of summer rainfall is such that deterioration of herbaceous cover over extensive areas could not greatly increase the flow of water into reservoirs during the summer period.

Any one torrential rain storm seldom covers a large area. Rains are spotted, showering on first one part of a watershed and then on another. Hundreds of miles of dry stream channels must be wet and re-wet during the summer. Flow reaching drainageways is largely dissipated by evaporation from gravel beds and by transpiration of stream-bottom vegetation.

From these studies and from observation of typical mountain slopes on other parts of the watershed, it is evident that where natural conditions are undisturbed, deep residual soils develop even on steep mountain slopes and that these soils support a dense protective cover of herbs and grasses supplemented by brush and tree cover. This natural cover has protected the soil beneath it for many centuries. Under such conditions precipitation infiltrates into the soil mantle and reaches natural drainageways via the underground route and soil erosion is negligible.

When natural conditions are upset by break-down of the protective vegetation, straight deep gullies which have the appearance of man-made ditches are formed. Under such conditions, torrential rain storms falling at infrequent intervals move great quantities of rock and soil down the slope. However, no appreciable increase in water delivery results from deterioration of vegetation cover on drained slopes to offset loss of topsoil and forage resources, flash-flood damage to roads, and silting of reservoirs.

## STABILIZATION OF SOILS

### Appalachian

Roadbank Fixation. During the past summer all roadbank stabilization plots were reexamined by J. W. Wood, assigned to the project by the Cherokee National Forest. An interesting fact has been brought out by this season's plot reexaminations regarding the way in which local vegetation is changing on stabilized banks.

A surprisingly large number of both light and heavy seeded species of tree seedlings are appearing naturally on stabilized banks of forest roads. For several years these young trees will not interfere greatly either with visibility or with the passage of cars. Just what will be the effects of widely branching trees when they have obtained considerable size remains to be determined.

Already growth on both fill and bank plots on which black locust has been planted for stabilization indicates that this species will interfere with traffic after three or four years. However, pitch and shortleaf pine as well as white pine tend to have narrower crowns and have not interfered with traffic even after ten years on special landscape plantings near Asheville, N. C.

Woody shrubs also are appearing naturally on stabilized banks in sufficient numbers to be significant in the landscaping. Among the most attractive appearing in the southern Appalachian region are hydrangea, Hydrangea arborescens, Jersey tea, Ceanothus americanus, witch hazel, Hamamelis virginiana, sumac, Rhus copallinum, and several other species of Rhus. Laurel, rhododendron, and azalea are also appearing, but more slowly. All indications are that with any effective stabilization treatment, natural seeding on stabilized banks will blend the roadway into the landscape.

### Rocky Mountain

Exclusion of Livestock as an Erosion Control Measure. In August 1939 a second biennial examination was made of eroding areas on the Cochetopa and Pike National Forests, which have been completely closed to grazing since 1936. Results confirm 1937 observations that the plant cover on these areas has been recovering steadily, though at a slow rate.

On Trail Creek on the Pike National Forest, herbaceous cover square-foot densities increased from 3.32 to 3.97 percent between 1937 and 1939: a 20-percent improvement over the first year's figures. In Bassam Park on the Cochetopa Forest, the herbaceous cover increased

173 percent from an initial square-foot density of 3.22 percent in 1936 to a value of 8.79 in 1939. On Trout Creek proper in the same forest, square-foot densities rose during the three-year period from 4.71 percent to 6.05 percent. For Chubb Gulch the corresponding figures are 3.70 and 6.39 percent. According to statistical criteria, all of these increases are highly significant.

## RANGE RESEARCH

### ARTIFICIAL REVEGETATION

#### Intermountain

Providing a Seed Source Through Cooperative Planting. A consideration that frequently forces itself into prominence at the time reseeding recommendations are being made is seed availability. Many native species which have proved their worth in experimental plantings are now ready to be released for a more extensive usage. But since the seed of such species have often been obtained only through collecting in native stands by trained personnel any large scale plantings are usually prohibited. To obtain or develop a more feasible seed source is highly desirable if research results are expected to be applied.

Several ranchers and farmers within the Intermountain Region have expressed their willingness to produce seed under cooperative agreements with the Experiment Station. The particular species which have been given to these growers are bluebunch, bearded, and beardless wheatgrass (Agropyron spicatum, A. subsecundum, A. inerme), blue wildrye (Elymus glaucus), and big bluegrass (Poa ampla). Enough seed has been supplied to plant at least an acre of every species except the last in all localities. Scarcity of seed has prevented supplying a comparable amount of big bluegrass to the growers.

Such an agreement provides the research organization with additional seed to make further plantings especially of the demonstrational type, which have not been possible in the past due to scarcity of seed. Strategically placed plantings are certain to arouse considerable local interest. This in turn will provide an outlet for the remaining seed produced by the cooperator. If these particular species prove to be as satisfactory in the future as they have in the past, the cooperator will experience no trouble in disposing of his marketable seed.

Such agreements wherein a seed source is developed should prove especially valuable to forest supervisors who are continually

on the alert for additional species that have been thoroughly tested and found ready.

Northern Rocky Mountain

Artificial Revegetation. Plans are under way for range tests in three or more places in the state for about 10 species that have shown most promise from small scale nursery tests. Test seedings will be done this fall and next spring.

The Bitterroot and Beaverhead forests have asked for advice and help in planning fall reseeding by the CCC on certain burned and depleted areas. Initial reports indicate a fair degree of success on burned areas reseeded on the Bitterroot last April. Crested wheatgrass was the species most used in this job but small amounts of other species were also planted.

A grazing test was continued the past season on a 47-acre field of crested wheatgrass at Miles City. During the 140-day period from May 8 to September 25, 12 yearling steers and heifers averaged 230 pounds' gain -- at the rate of about 1.6 pounds per day. Gains were considerably below this average during July when the crested wheatgrass was dry and harsh. Late July rains provided some green growth and a better rate of gain prevailed during August, but the rate of gain dropped below one pound per day in September. Sufficient cattle were not available to graze the crested wheatgrass more heavily in the spring and early summer which appears to be the best management practice for it. An adjacent native grass pasture of 34 acres was also grazed by similar yearlings until early August when it became necessary to remove them because of feed shortage. They were then placed on the crested wheatgrass pasture with the other 12 yearlings. These six yearlings obtained approximately 16½ months' feed from 34 acres of native pasture and gained at a slightly higher rate for 2-3/4 months as compared to 60 months' feed furnished during about 4½ months by the 47-acre crested wheatgrass pasture. When the yearlings were removed from this pasture late in September, there was plenty of crested wheatgrass left, but it was quite dry. Final conclusions as to the relative merits of native with crested wheatgrass ranges may not be safely drawn from this preliminary test, but there can be no doubt that forage production was very much greater on the latter.

## GRAZING MANAGEMENT

Appalachian

Initiation of Grazing Studies. Studies of the relation of forest grazing to beef cattle production in the southeastern states

are being initiated at this Station through new funds appropriated in the fiscal year 1941. The investigations will be initiated primarily in the coastal plains in cooperation with the Bureaus of Animal and Plant Industry and the State Agricultural Experiment Stations in North Carolina and Georgia. The findings will apply, at least to some extent, to approximately two-third of the total land area in the Southeast, this portion being occupied by forest and carpeted with coarse grass and underbrush. Cutover lands compose a high percentage of this two-thirds.

In certain sections of the forest areas many cattle already are being grazed, and with the development of more profitable systems of beef cattle management the possibilities are that the number of animals grazed will increase in the next few years. If so, this will supply the farmer with a diet containing more meat, as well as with a larger and more diversified source of income, without competing seriously with other beef-producing areas.

At present, very little is known as to the most economic methods of forest grazing and cattle production in the Southeast and the studies being initiated will likely be along at least part of the following lines:

A. Range Forage

1. Makeup of vegetation on important grazed forest types.

2. Growth characteristics and growth requirements of important grazed plants.

3. Utilization and palatability of important plants.

4. Nutritional values of important plants.

B. Forest Range Management

1. Management practices, including their effect on range forage, trees, and animals, such as:

a. Intensity and season of grazing.
b. Rotational and other systems of grazing.
c. Forest burning.

2. Grazing capacity as related to other factors of management and forage growth.

C. Beef Cattle Production

1. Production of feeder cattle.

a. Controlled versus year-long breeding season for breeding herd.
b. Correcting nutritional deficiencies.
c. Wintering on range with and without supplementary feeds, versus wintering on farm pastures or harvested feeds in dry lot for breeding herd and feeder stock.
d. Other seasonal grazing and feeding problems.
e. Creep-fed versus non-creep-fed calves.

2. Production of slaughter cattle.

a. Methods of creep-feeding calves.
b. Methods of finishing yearlings and two-year-old feeders through various types of supplementary feeding on the forest range versus use of harvested feeds in the dry lot, and in coordination with cultivated pastures.

D. Values from various range and livestock practices on forest and related farm lands in relation to range forage and feed costs and to cattle and timber production.

California

Grazing Management. Completion of a problem analysis for the East Side region of the State, as a basis for guiding the next steps in the range-study program, occupied much of the time of Hormay and Bentley during the past four months. The analysis is now being reviewed by the Regional Office and by the several forest supervisors who participated in it.

In connection with current work on study plans, a mountain-meadow pasture area has been tentatively selected to supplement the Burgess Spring cut-over pasture (Lassen N.F.) in the study of seasonal values of mountain forage.

Dr. H. H. Biswell, range technician at the San Joaquin Experimental Range for the past four years, transferred on September 1 to the Appalachian Station to head up the work there being organized on forest grazing problems of the Southeast.

Effect on Range Forage of Interrupted Rainy Season. In previous reports mention has been made of the wide fluctuations in the make-up of the forage carpet on the San Joaquin foothills where most of the plants are short-lived annuals. These fluctuations in composition mean, of course, that the forage value of this range feed varies from season to season. During the past year weather conditions not encountered during the four preceding years resulted

in a rather extreme contrast in abundance of three of the most common plants. Broadleaf alfileria (Erodium botrys), was far more abundant than in any year since the studies were started in 1935. Offsetting the marked increase in alfileria was a corresponding decrease in soft chess (Bromus mollis) and foxtail fescue (Festuca megalura); in fact, both of these grasses were less abundant than in any of the four preceding years. The big differences between consecutive years are shown in the following table.

| Species | Year | |
|---|---|---|
| | 1939 | 1940 |
| Erodium botrys | 28.1 | 53.7 |
| Festuca megalura | 12.9 | 6.8 |
| Bromus mollis | 26.7 | 5.9 |

The significance of these changes is indicated by a rough comparison of the feed values of these plants. Both broadleaf alfileria and foxtail fescue are considered poor forage for cattle during the summer period after they dry, but soft chess at that time is a fairly good feed. Changes in the relative abundance of these two plants thus affect the value of the forage crop as a whole. Also, it is likely that the nutritive value of a forage crop made up chiefly of alfileria may be diminished more by untimely rains either in late spring or early fall than in the case of a crop made up chiefly of grasses. Grasses withstand trampling better.

The changes in forage cover here alluded to are attributed chiefly to several weeks of dry weather which followed the first rain of the season. Precipitation of 1.2 inches, which fell on September 26, started general germination, but most of the shallow-rooted plants such as soft chess died during the dry period which followed; while the deep-rooted species such as broadleaf alfileria survived, Moreover, the deep-rooted species, established as they were when the rains resumed later in the season, had a distinct advantage over the new crop of grass seedlings that germinated at that time. Practically no space was then left for new grass seedlings to occupy.

Based on a limited number of excavations on December 5, soft chess roots penetrated to an average depth of 9 inches, foxtail chess 6½ inches. In contrast, broadleaf alfileria roots extended to a depth of 36 inches -- so deep that they were actually using moisture from the preceding season.

An interesting observation is the tendency of broadleaf alfileria to raise its leaves somewhat during extremely dry

periods. The availability of short plants to cattle is thus increased. During the dry period mentioned in this note, the average height of this species was increased almost 1/2 inch, from this cause alone.

The effects here noted were most severe on southerly exposures. On northerly exposures the shallow-rooted species survived longer, and considerable green forage aided in bridging the dry-period gap. After the rainy season had resumed in earnest, mild temperatures resulted in good winter and early spring growth of forage on all exposures, and cattle made good gains.

Intermountain

Field Days at Desert Experiment Station. Well attended and well received field days were held in late September at the Desert Branch Experiment Station. Although this is a busy part of the year for stockmen, a large group found time to attend, and expressed themselves as well repaid. Utah and Nevada groups attended separately, each for one and a half days. September 24 and 25 were visiting days for Utah, during which time the experiments were viewed by 110 men, of whom about 75 were stockmen. September 26 and 27 were Nevada days and brought an attendance of 61, of whom about 45 were stockmen. The field days were conducted in cooperation with the Agricultural Extension Services of Utah and Nevada, respectively. W. W. Owens, assistant director of Extension, was in charge for Utah and Thomas Buckman, director of Extension, for Nevada. Stewart and Hutchings of the Experiment Station staff conducted the field trips, explained the points to observe, and the conclusions to be drawn from each stop.

High interest was shown in those experiments which compared (1) the effects of heavy grazing with those of drought; (2) the effects of moderate grazing with complete protection; (3) the effects of managed grazing with unmanaged; and (4) the animal response to managed grazing.

The drought year of 1940, for example, produced 72 percent as much forage on moderately grazed pastures as was produced in 1938, the wettest year since the station began, whereas the heavily grazed pastures produced only 39 percent as much. On the gently sloping station areas, moderate grazing since 1933 was shown to be practically as effective in restoring range as was complete protection. Managed grazing has brought about a condition of about twice as much forage as on unmanaged range. Sheep were also shown to have produced on the average a pound more wool on moderately grazed areas, to have a body weight about 10 pounds heavier and to have yielded a better lamb crop than on unmanaged range. Managed grazing was defined for the desert as range grazed at the season for which it is suited and which leaves about 25 percent of yearly forage produced unused at the end of the grazing season.

Additional points of interest were the rapid rate at which rice-grass, winterfat, and black sage on range previously severely grazed recovered under managed grazing; the considerable increase in five years on moderately grazed as compared with heavily grazed range; the general use of the grazing district by sheep in winter and by a rather small number of cattle during the entire year; and the apparently beneficial effect of alternation of fall and winter grazing as compared with continued use in either fall or winter.

The excursion was kept strictly on schedule, which added to the good reception otherwise accorded. A loud speaker, carefully prepared charts and tables, together with oral explanations were employed to convey the points to the visitors. Mimeographed programs containing essential data for each stop were distributed at the beginning of the field trip.

Spring-Fall Range

Lamb Weights. Since it is common practice for ewes to be lambed on the range, this is the type practice adopted for use in experimental grazing studies being conducted at the U. S. Sheep Experiment Station. Pregnant ewes put in the pastures at the beginning of the study each year, approximately April 24, were lambed during the first 20 days of the grazing season.

Owing to this practice the lamb weight at the end of the spring grazing season, approximately June 22, may have been influenced by the effects of grazing systems, of birth weight, and of age. Differences caused by the effect of grazing systems, as indicated by the lamb weights at the end of the season, may have been, therefore, obscured by chance differences in birth weight and age. Furthermore, variation introduced by differences in birth weight and age might prevent the detection of small but significant treatment effects.

A preliminary investigation conducted in 1936 regarding the data from 900 lambs indicated that covariance analysis, using birth weight and age as two independent variables, could be profitably employed in the analysis of lamb data. The precision in defining differences that resulted from grazing treatments was doubled. Regression of lamb weight, at the end of the spring grazing season, on birth weight and age did not differ significantly from linear when lamb ages differed only 20 days.

Accordingly, in grazing studies, records for each lamb were kept on its birth weight and date of birth, for each of 4 years, and adjustments made for differences in birth weight and age. As a result of this practice, precision has been doubled in each of the 4 years. Regression coefficients shown in table 1 are sufficiently homogeneous that a single regression may be used for making adjustments in the data and for the resultant test of significance.

Table 1.-Summary of multiple regression coefficients of lamb weights at the end of the grazing season (y) on age ($x_1$) and birth weight ($x_2$) during the 4 years of the grazing study, 1937 to 1940, inclusive.

| Year | $b_1$ | $b_2$ |
|---|---|---|
| 1937 | 0.6806 | 2.3184 |
| 1938 | .6607 | 2.4004 |
| 1939 | .6764 | 2.6633 |
| 1940 | .5714 | 2.4157 |

It is believed that the use of covariance analysis may be, in many cases, profitably employed when dealing with similar data. This may be especially true when its use is planned in the design of the experiment.

Desert Range

Forage Reduction by Drought and Heavy Grazing. The forage production in 1940, the year of greatest drought up to September 1, was 28 percent lower on moderately grazed range and 61 percent less on heavily grazed than in 1938, the year of highest precipitation since the Desert Experiment Station was started. Two pastures side by side had both been grazed for four years, during January and February, permitting a comparison of the effects of drought and severe grazing. The rate of stocking on the pastures is given in table 1, which shows that in general Paddock 1 has been grazed approximately 25 percent heavier than Paddock 2.

Table 1.-Record of use on Paddocks 1 and 2 for 1937-38, 1938-39, and 1939-40.

| Year | Sheep-Days Use | |
|---|---|---|
| | P - 1 | P - 2 |
| 1937-38 | 3,762 | 3,158 |
| 1938-39 | 4,452 | 3,483 |
| 1939-40 | 4,499 | 3,626 |
| Totals | 12,713 | 10,267 |

Table 2 presents a comparison of the absolute and relative differences in density by species on Paddocks 1 and 2 for the years 1937-1940.

Table 2.-Comparison of density differences on Paddocks 1 and 2 for 1937-1940, inclusive.

| | Density difference and years | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Absolute | | | | Relative 1/ | | | |
| | 1937 | 1938 | 1939 | 1940 | 1937 | 1938 | 1939 | 1940 |
| Blue grama (Bouteloua gracilis) | -.179 | -.051 | +.043 | +.037 | 0 | .128 | .222 | .216 |
| Curly grass (Hilaria jamesii) | -.038 | +.073 | +.096 | +.109 | 0 | .111 | .134 | .147 |
| Ricegrass (Oryzopsis hymenoides) | -.003 | +.073 | +.062 | +.054 | 0 | +.076 | +.065 | +.057 |
| Dropseed (Sporobolus cryptandrus) | +.253 | +.442 | +.465 | +.321 | 0 | +.189 | +.203 | +.068 |
| Other grass | -.028 | -.093 | +.062 | +.015 | 0 | -.065 | +.090 | +.043 |
| Mallow (Sphaeralcea grossulariaefolia) | -.045 | +.025 | +.036 | +.026 | | | | |
| Russian thistle (Salsola pestifer) | .001 | .004 | .002 | - | | | | |
| Other weeds | .010 | .037 | .013 | .012 | | | | |
| Shadscale (Atriples confertifolia) | -.263 | -.300 | -.140 | -.241 | 0 | -.037 | +.123 | +.022 |
| Rabbitbrush (Chrysothamnus stenophyllus) | -.008 | +.012 | +.007 | +.004 | 0 | +.020 | +.015 | +.012 |
| White sage (Eurotia lanata) | -.139 | +.047 | +.096 | -.057 | 0 | +.186 | +.235 | -.082 |
| Snakeweed (Gutierrezia sarothrae) | -.019 | -.035 | -.022 | -.032 | 0 | -.016 | -.003 | -.013 |
| Other browse | -.411 | -.142 | -.131 | -.055 | 0 | +.269 | +.280 | +.356 |
| Totals | -.891 | +.084 | +.512 | +.169 | 0 | +.975 | +1.403 | +1.060 |

1/Relative differences are really increases or decreases since 1937, at which time all differences are equated to zero, that is, as being point of origin.

All species, with the exception of rabbit-brush and white sage increased in density in Paddock 2 as compared with Paddock 1. With a number of species such as curlygrass, grama grass, and ricegrass, these increases are highly significant. The total net increase is more than 30 percent.

In 1938 weight estimates on forage production were initiated, and Paddock 1 and Paddock 2 produced within 4 pounds the same total amount of forage (table 3).

Table 3.-Comparison of forage produced on Paddocks 1 (heavily grazed) and 2 (moderately grazed), 1938-1940.

| | Usable pounds per acre | | | |
|---|---|---|---|---|
| | P - 1 | | P - 2 | |
| | 1938 | 1940 | 1938 | 1940 |
| Blue grama (Bouteloua gracilis) | 2.65 | 0.56 | 2.48 | 1.10 |
| Curlygrass (Hilaria jamesii) | 18.01 | 8.25 | 23.60 | 16.77 |
| Ricegrass (Oryzopsis hymenoides) | 5.98 | 2.52 | 10.40 | 7.46 |
| Dropseed (Sporobolus cryptandrus) | 4.19 | 1.17 | 9.02 | 2.74 |
| Shadscale (Atriplex confertifolia) | 31.46 | 8.50 | 20.12 | 5.56 |
| Budsage (Artemisia spinescens) | 3.30 | 3.06 | 2.82 | 2.89 |
| Rabbitbrush (Chrysothamnus stenophyllus) | 0.02 | -- | 0.19 | 0.05 |
| Snakeweed (Gutierrezia sarothrae) | 8.11 | 4.29 | 10.33 | 4.43 |

When converted to usable pounds per acre, Paddock 2 produced approximately 5 pounds more forage per acre than did Paddock 1. By 1940 Paddock 1 showed a decrease in forage production of 62 percent. While a considerable amount of the decrease in forage production was no doubt due to the severe drought conditions of 1940, the differential decrease between Paddocks 1 and 2 must be attributed to the difference in the intensity of use. The more palatable species such as ricegrass and curlygrass apparently suffered the greatest losses. Under heavy grazing in Paddock 1, curlygrass shows a decrease in usable forage production of 56 percent and ricegrass a decrease of 58 percent. Under moderate grazing in Paddock 2, the reduction was only 39 and 28 percent for these two species. Under heavy grazing in Paddock 2, sheep in a 40-day period showed a loss in body weight of approximately 3 pounds, while the sheep subjected to moderate grazing in Paddock 2 showed a gain of 2.75 pounds a head. Heavy grazing comparable to the outside range is also causing a material reduction in forage production, reducing the plant cover. Sheep also winter in much poorer condition than they do on the moderately grazed area.

That the forage production on moderately grazed range was 72 percent as great as in the most favorable year is highly important in view of the fact that on heavily grazed range, treated alike in every respect save a 25-percent increase in stocking, the forage production was only 39 percent of that produced in a good year. It is infinitely easier for a stockman to adjust to 72 percent feed supply than to one of 39 percent.

Drought, in this case, reduced forage production 28 percent, and severe grazing as compared with moderate grazing an additional 33 percent, making a decrease of 61 percent drought and severe grazing combined.

Summer Ranges

Reorientation of Range Research Program. The last job in the program of cleaning up old work at the Great Basin Branch Station will soon be completed, so that orientation of future effort is now in order. In August Chapline met with members of the Intermountain staff to discuss future research on summer ranges.

Three fundamental ideas tended to govern the discussion. These were:

1. Whatever research is done should have general application to mountain range problems in the Intermountain region, rather than specialized application to any one limited area. Studies must necessarily be specific, and some sorts must be conducted on a limited area, but they must be formulated so that their results will be widely usable.

2. Plants, soil, and water are interdependent and of joint resource value on mountain rangelands. In an ecological approach one of the three cannot be isolated for long from the other two, and when the human community is taken into account, as it must be, the economic problems of resource use must be reckoned with also. Thus there are four major interlocking phases in mountain range problems.

3. Research effort should be so directed as to increase our knowledge of the basic factors which govern the growth, development, and decay of plants and plant communities, the processes of soil building and soil destruction, and the processes of water accumulation and yield. The fundamental ecological concepts, imperfect as they are today, are of such great value in management practice that their further development and the development of new concepts gives promise of immensely valuable application.

It was felt that the Great Basin Branch Station, which has necessarily concentrated its efforts toward completion of specific studies laid down years ago, may now well afford time in developing the comprehensive perspective essential to planning new work of the scope required. It was believed that a careful survey is needed to determine whether any acute present-day problems may have higher priority than studies suggested by past research. A two-phase program was decided on for the immediate future. One phase is a survey of range management problems and problem areas, with reference to soil and water as well as forage and economic problems. The other phase is an ecological reconnaissance of the Wasatch Plateau, building upon the results of previous research at the Great Basin Station, especially the early work of Sampson.

The survey of management problems, in which it is hoped to enlist the help of the Region, will necessarily be region-wide in scope. While the Station already has considerable grasp of broad summer-range problems, the trouble is that there are too many of them, and in a research program the Station must restrict its effort

to the one or two which are most urgent and significant. The definition and formulation of problems is an important task, but the main purpose of this phase is critical, that is, to assess priorities.

The ecological reconnaissance will be essentially observational. Its emphasis will be upon determining the basic physical factors which govern:

1. Distribution of plant associations,

2. Succesional processes,

3. Soil building and soil erosion, as affected by plants and plant associations with their attendant microclimates,

4. Plant invasion, establishment, competition, and removal, as affected by soil building or soil loss as well as by direct herbage removal, and

5. Differences between forage production, soil protection, and water loss under the major vegetal cover types.

With the background developed by this two-phase study it is felt that a program of mountain-range research can be developed which will be thoroughly comprehensive. Merely as an illustration of the procedure contemplated, suppose the survey reveals that the problem of highest priority is the short-time determination of range trends. Concurrent observational study may also indicate, for example, that the development of criteria is required by which the range manager can detect the process of depletion in its initial stages. At the same time, close observational study of the essential processes which encourage or prevent development of soils and plant communities may also be expected to yield important clues as to the nature of criteria which may be useful, as well as the means of developing them. The final working out of the problem may be quickly accomplished or it may require years of effort, but in any case the exploratory program is intended to serve both as a foundation and as a guide to future research.

Some Economic and Social Aspects of a Big Game Program. In the situations where there is competition between big game and domestic livestock for the use of range on the national forests, it can generally be shown in economic terms that the value of the livestock production is several times the expenditures of hunters and the value of meat secured from game.

There has been a recent tendency on the part of livestock interests to sum these data up on a state basis and conclude that the only part of big game economics of significance to the state is the sale of out-of-state licenses, since they bring "new wealth" to the state, but that the production of beef, lamb, and wool, instead of

game, all means added income from a state standpoint. The question is then raised, "Can the state afford this disparity between incomes from game and from livestock, where choice is involved?"

Public land management has only very inadequate biological information regarding where and to what extent a choice is involved due to competition between livestock and big game. But, assuming that such information is available and that a choice must be made, a strictly economic analysis along state lines is untenable. Our national economic organization does not follow state lines, but rests upon such transactions as the exchange of western beef for eastern-made sports equipment, and the policy question is whether in our national economic life these lands can be used for recreational purposes or are needed for livestock production.

Economics calculations cannot give us the whole picture which is needed for answering this question. A charge for hunting privileges that would yield maximum revenue for the use of land in producing big game would undoubtedly yield much more revenue than is now being realized, but would also deny some people a form of recreation which they evidently desire. Can one reduce the social benefits of recreation to mere economic calculation -- can one put the "dollar sign" on the health and inspiration which is derived from out-of-door recreation?

Lake States

Chapline visited the Denbigh branch in North Dakota in midsummer to look into the possibility of conducting range research in the sand hills along with the current studies of tree planting. Present Station recommendations for tree planting do not contemplate solid forest planting on large areas but only on the dunes proper and as shelterbelts in connection with stock raising, with some supplemental planting along highways for recreational purposes. The main economy of the sand hills of North Dakota is based on cattle raising. Although the range basically has a high carrying capacity, it has been badly abused and there is much evidence of wind erosion. Moreover, there is a large acreage of "go-back land", land that was formerly cultivated and now needs reseeding to valuable range species.

Chapline was evidently impressed by the need for range research in this section, possibly to be combined with additional work in the sand hills of Nebraska.

Northern Rocky Mountain

The 1940 season has been the third consecutive year of generally favorable conditions for the recovery of drought-depleted ranges of

Montana. Three dry spots developed since April, centering at Missoula, Livingston, and Great Falls, but growing season precipitation has been close to or a little above normal over the state generally, and it has been unusually timely. This, coupled with fewer livestock than a few years ago, has resulted in another splendid grass crop and a sharp uptrend in density for many depleted ranges. Fall growth is now well started from September rains in many places. Surprising are the number of reports of water shortage. Many formerly dependable springs failed this fall and restricted runoff leaves many storage dams dry.

Restocking of ranges is proceeding at a conservative rate and a nice reserve of grass as well as of haystacks is evident in many range areas. High prices for replacement stock and recollections of distressed conditions during drought years both tend to keep the rate of restocking within conservative limits for the most part.

Calves on conservatively grazed experimental pastures at Miles City are about 40 pounds heavier than those on heavily grazed ranges and there is a similar difference in weight of cows. The differences are expected to be still greater at weaning time late in October. Density trends on all these pastures have continued upward at a good rate since 1939, but compilation of 1940 data has not proceeded far enough to tell how close they are to pre-drought levels. Doubtless the recovery would have been far less striking had one or more of the past three seasons been droughty.

Pacific Northwest

The Acting Chief on July 11, 1940, officially designated a 24,314-acre tract in the Umatilla National Forest as the Starkey Experimental Range. It is planned to conduct research in management of cattle summer range on this area with the objective of determining a practical method whereby reasonably full use may be made of range in the ponderosa pine type and maintain or improve range conditions on interspersed open grassland and meadow types. Studies of the correlation of body weights with the method of management and of forage production with climatic conditions are contemplated as well as some investigations on range utilization standards and on artificial reseeding. The experimental range by virtue of its central location also will serve as a field headquarters for other range studies that may be conducted not necessarily on the Starkey area. The Region and the Station are cooperating in plans for developing necessary improvements on the range.

The Station cooperated with the Region and with Oregon State Agricultural Experiment Station in obtaining data on density, composition, utilization, and grazing capacity for a sheep allotment on the Whitman National Forest on which Oregon State College and the

Forest Service plan joint experiments on range and sheep management. This allotment, known as the Bull Run, is in the ponderosa pine type, a short distance southeast of the Starkey Experimental Range. Plans drawn up from the results of the surveys made this summer will serve as the basis of future research on this area. It is tentatively planned to test several intensities of use on the vegetation of the area in order to measure the effects on body weight of sheep and on the range forage.

Pickford and Reid have completed two manuscripts to the stage of submission to a board of review. One, entitled "Effective Range Surveys as a Factor in Range Management", summarizes the results of the 1939 field study that compared the standard range survey methods. The second, entitled "Judging Condition and Utilization of Subalpine Grassland Ranges of Oregon and Washington", is the result of the utilization standards research by this Station in the subalpine range type. These articles will be submitted shortly for U.S.D.A. publications.

Rocky Mountain

Comparison of Protected and Grazed Areas. A study of 139 protected and adjacent grazed areas in Colorado and Wyoming has revealed that contrasts are not always as might be expected from casual consideration. Prolonged drought, for example, may keep vegetation on both grazed and ungrazed areas at a low point for several years. Concentrations of rodents may obstruct the normal changes that would occur after the exclusion of livestock. Likewise, areas in depleted condition may lack potentiality for forage production with the result that enclosures show no results.

In 14 percent of the comparisons made, vegetation density was greater on grazed than on protected portions of the range. One factor offered in explanation of this finding, particularly in short-grass vegetation, is competition for soil moisture. Apparently removal of foliage by grazing animals reduces the leaf surface of the grasses and lowers transpiration. This results in conservation of soil moisture by decreasing the demands on the supplies of water that are available. Under these conditions the grazed plants are better able to withstand drought than the ungrazed vegetation which has greater leafage and makes heavier demands on soil moisture. The result is that many more ungrazed than grazed plants die during periods of drought stress.

The most striking contrasts in forage value were apparent between grazed ranges and areas that had been enclosed for long periods. On 22 areas from which livestock had been excluded for more than 30 years, 36 percent of the density consisted of plants of low palatability. On adjacent open ranges, plants of low palatability comprised

49 percent of the density. Plants of high palatabilities constituted 64 percent of the total density on protected ranges and 51 percent on the corresponding grazed areas.

Rainfall on Experimental Pastures. The value of numerous rain gages on a localized area was demonstrated on the Central Plains Experimental Range during the 1940 growing season. Twenty-eight gages were installed to measure the amount of rainfall received by individual experimental pastures. A total variation of 7.19 to 11.22 inches was recorded, and gages only one mile apart differed as much as one inch. These variations were due largely to the sporadic nature of storms on the Great Plains, and resulted in localized "drought" areas in a year of abnormally high precipitation. Without complete rainfall records for experimental pastures comprising several square miles, evaluation and interpretation of forage production and cattle weight gains would be difficult.

Chemical Eradication of Orange Sneezeweed. Plots heavily infested with orange sneezeweed were treated by applications of various amounts of borax, borax mixed with sodium chlorate and a borate ore (Colemanite) during 1939. The chemicals were applied dry to the soil during late June, mid-August, and early September at rates of 4, 8, and 12 pounds per plot (300, 600, and 900 pounds per acre).

The results of these treatments one year after application indicate that chemical control of orange sneezeweed in heavily infested patches may be economically feasible; however, conditions are changing constantly so it may be several years before the most desirable treatment is known.

The 12-pound rates of borax or the 8- and 12-pound rates of borax-sodium chlorate mixture practically denuded the treated areas of all vegetation. Both chemicals were effective in eradicating sneezeweed when applied at either of the three rates. The action of Colemanite was slower than with the other chemicals and sneezeweed was not affected until late in 1940 when it began to turn yellow. Apparently 4 pounds of borax-sodium chlorate, 8 pounds of borax, or 12 pounds of Colemanite are equally effective in eradicating sneezeweed. However, the powerful sodium chlorate mixture tends to kill all kinds of plants, whereas the straight borax is selective in that it kills most of the sneezeweed and other weeds but kills very little of the grasses.

The chemicals applied in September were about twice as effective as those applied in June and August. Four pounds of borax applied in September was about as effective as 8 pounds in June.

It is significant that on most of the plots treated with 4 or 8 pounds of borax, sneezeweed was practically eradicated, but the grasses survived and made greater growth than on surrounding untreated areas. This was most striking on plot 55 treated with 8 pounds of

borax in June 1939. When examined in July 1940 this plot had as great or greater density of grass than the adjacent check plot and the flowerstalks were taller than on the untreated area. Height measurements of the 20 tallest flowerstalks on both areas averaged as follows: Agropyron pauciflorum, 48.1 inches on the treated plot and 35.6 inches on the check plot; Trisetum spicatum, 30.9 inches as compared to 20.4 inches, and Poa fendleriana, 26.0 inches as compared to 18.4 inches.

Lessened competition for water where weeds were killed by borax probably accounted for part of the greater growth of grasses on the treated plot, but the evidence indicates that borax had some fertilizer effect.

The total cost for applying 300 pounds of borax is $11.24 per acre and $14.10/acre for 300 pounds of borax-sodium chlorate. However, the 1940 tests may show that the amount of chemical can be cut in half. Moreover, an even smaller quantity of the chemicals may effectively control sneezeweed by killing part of the sneezeweed and at the same time fertilizing the grasses. It is also possible that a less pure and less expensive form of borax can be obtained. Even at $12.00 per acre there are many areas on driveways or in newly infested spots where eradication will be feasible in order to protect surrounding areas from invasion.

Southwestern

Mesquite Sandhill Restoration. The 640-acre Mesquite Sandhills Natural Revegetation Enclosure at the Jornada Experimental Range was established in June 1930 and surveyed by intensive reconnaissance in August and September 1932. Vegetation within the enclosure falls into three main types: (1) typical mesquite sandhills characterized by mesquite-capped sand dunes with barren interdunal blowouts; (2) a mesquite-dominated type in which weeds, grasses, and other shrubs, chiefly snakeweed, constitute a partial cover of the blowouts; and (3) a type consisting largely of perennial grasses but with varying proportions of mesquite and snakeweed. In February and March 1935, two 300 x 300-foot plots were laid out side by side in a snakeweed-mesquite-grass type just within the 640-acre enclosure and a third like-sized plot laid out in the same type just outside the enclosure. A rodent-proof fence was built around one of the inside plots. It should be noted that, although these plots were established two seasons after the large enclosure was built and the vegetation surveyed, conditions of the three plots at the time of establishment were considered to be similar.

Inspection of the plots in the early summer of 1940, five growing seasons after establishment, discloses a substantial difference in density and composition of vegetation between the three plots. Comparision of present conditions with those recorded for the area in 1932 also shows considerable change in two of the plots. Vegetation

density and composition figures for the area in 1932 and the three plots in 1940 together with notes on utilization and reproduction of grasses and stability of soil are given in the accompanying table.

This table shows the very real improvement of the rodent and cattle exclusion plot and the marked deterioration of the plot open to cattle and rodents since their establishment. By far most of the improvement in the rodent and cattle exclusion plot has been in the increase of perennial grasses, chiefly Sporobolus flexuosus and Bouteloua eriopoda. This increase has been more than enough to offset a considerable loss in density of cover due to drought kill of Gutierrezia in 1934. The plot open to rodents and cattle suffered the same drought loss of Gutierrezia as the others and this was not at all compensated for by a subsequent increase of grass density; in fact, grasses also decreased on the plot. The plot closed to cattle but open to rodents has shown a possible slight decrease in total density, again owing to drought loss of Gutierrezia, but grass density has increased over the 1932 condition, and density of Gutierrezia shows a higher value than on the other two plots.

It is worthy of emphasis that the increase in grasses on the total protection plot is associated with nonuse, which has resulted in protection of the soil from erosion by wind and permitted the reproduction of the grasses. By contrast, the close utilization of grasses on the other plots has resulted not only in destruction of flower stalks and stolons of black grama but has created unstable conditions of the soil surface which are adverse to the establishment of grass seedlings or sets of black grama.

Comparison of rodent and cattle exclusion, cattle exclusion, and open plots, Jornada Mesquite Sandhills Natural Revegetation Enclosure, with each other in 1940 and with condition of the type in 1932.

| Principal plant species | 1932 | | 1940 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | General site | | Cattle and rodent exclusion | | Cattle exclusion | | Open to cattle and rodents | |
| | Comp. pct. | Density | Comp. pct. | Density | Comp. pct. | Density | Comp. pct. | Density |
| Woods: | | | | | | | | |
| Hoffmanseggia | 1 | .0018 | | | | | | |
| Solanum | 1 | .0018 | | | | | | |
| Cassia bauhinoides | | | 1 | .0025 | 3 | .0045 | 2 | .0020 |
| Others | 5 | .0090 | 1 | .0025 | T | - | - | |
| Total weeds | 7 | .0126 | 2 | .0050 | 3 | .0045 | 2 | .0020 |
| Grasses: | | | | | | | | |
| Bouteloua eriopoda | 5 | .0090 | 25 | .0625 | 15 | .0225 | 2 | .0020 |
| Sporobolus flexuosus | 5 | .0090 | 50 | .1250 | 23 | .0345 | 4 | .0040 |
| Aristida spp. | 3 | .0054 | 3 | .0075 | | | 2 | .0020 |
| Triodia pulchella | 1 | .0018 | | | 1 | .0015 | | |
| Muhlenbergia porteri | 1 | .0018 | | | | | | |
| Chaetochloa macrostachya | | | 1 | .0025 | 1 | .0015 | | |
| Panicum hallii | | | 1 | .0025 | | | | |
| Total grasses | 15 | .0270 | 80 | .2000 | 40 | .0600 | 8 | .0080 |
| Browse: | | | | | | | | |
| Prosopsis glandulosa | 18 | .0324 | 9 | .0225 | 30 | .0450 | 75 | .0750 |
| Gutierrezia sarothrae | 58 | .1044 | 6 | .0150 | 25 | .0375 | 12 | .0120 |
| Yucca elata | 2 | .0036 | 2 | .0050 | 2 | .0030 | 3 | .0030 |
| Atriplex canescens | | | 1 | .0025 | | | | |
| Total browse | 78 | .1404 | 18 | .0450 | 57 | .0855 | 90 | .0900 |
| Total vegetation | 100 | .1800 | 100 | .2500 | 100 | .1500 | 100 | .1000 |
| Utilization: | | | | | | | | |
| Bouteloua eriopoda | | | None | | Heavy | | Very heavy | |
| Sporobolus flexuosus | | | None | | Moderate | | Heavy | |
| Aristida | | | None | | Light | | Light | |
| Reproduction: | | | | | | | | |
| Bouteloua eriopoda | | | Good, many sets | | Poor, few sets | | None | |
| Sporobolus flexuosus | | | Good, many young plants/served | | None observed | | None | |
| Aristida | | | None observed | | None observed | | None | |
| Soil stability: | | | Good, no sand deposit | | Poor, some sand deposit and wind scouring | | Very poor, heavy sand deposit and much wind scouring | |

These observations are indicative of the definite and possibly critically retarding effect of livestock and rodents, especially the latter, in the natural revegetation of partly deteriorated black grama range lands; that is, black grama range which has not been converted to the extremely deteriorated condition in which mesquite wholly dominates the area. This limitation as to degree of deterioration or mesquite dominance under which improvement by rodent and livestock control may be expected is imposed by other observations on the Jornada. These latter observations have shown that where mesquite fully dominates an area, and the typical mesquite sandhills exist, protection from livestock and rodents fails to bring about any improvement in vegetation cover. As a matter of fact, there is good reason to consider that cattle and rodent exclusion has not been the sole factor accounting for the difference developed between the three plots, since mesquite density alone increases quite definitely from the rodent and cattle exclusion plot to the plot open to cattle and rodents, and the transition to full mesquite domination is complete within 300 feet or so from the plot open to cattle and rodents.

Observations on and around the plot open to cattle and rodents indicate that the more abundant mesquite on the plot and the proximity of the typical mesquite sandhills close by are certainly partly responsible for the deterioration of vegetation on this plot since its establishment. This observation does not, however, detract from the conclusion that below a certain degree of mesquite infestation and dominance, control of cattle and rodents will effect a real improvement in deteriorated grama grass ranges.

Measurement of Forage Utilization.[1/] A utilization survey based on a random sample of stubble height measurements of all perennial grasses obtained through the use of a modified line interception method was completed for the Santa Rita Experimental Range on June 28, 1940. In this survey 362 randomly located sampling units each 100 feet long were measured. These data have been analyzed, and the following information concerning the composition and grazing use of the perennial grasses obtained:

Composition: A complete list of perennial grasses encountered and the percent of composition represented by each is contained in table 1. These 22 species of grass are widely distributed over the range and provide a variety of forage. The grama grasses (Bouteloua spp.), of which seven species make up nearly 57 percent of the total composition, are dominant throughout most of the range area. The low percentage of Rothrock grama (B. rothrockii), which ordinarily is quite abundant, should be noted. This grass, excepting in years of drought, is one of the most common grasses. Failure of Rothrock grama doubtless has caused its share of the grazing to be shifted on to other forage plants.

Utilization by pastures: The utilization estimates were based on measurements of the stubble height of previous season's

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1/ The tables in this report were prepared with the assistance of WPA Project O.P. No. 101-2-02-170.

Table 1.-Percentage composition of perennial grasses for the entire Santa Rita based on 362 sampling units.

| Plant Name | Composition |
|---|---|
| | Percent |
| Aristida spp. | 0.02 |
| Aristida divaricata | 4.63 |
| Aristida glauca | 8.73 |
| Andropogon saccharoides | .10 |
| Bouteloua chondrosioides | 14.28 |
| Bouteloua curtipendula | 8.31 |
| Bouteloua eriopoda | 11.70 |
| Bouteloua filiformis | 20.97 |
| Bouteloua gracilis | 0.44 |
| Bouteloua hirsuta | 2.92 |
| Bouteloua rothrockii | 0.36 |
| Hilaria belangeri | 5.65 |
| Heteropogon contortus | 2.97 |
| Leptochloa dubia | 0.82 |
| Lycurus phleoides | 0.04 |
| Muhlenbergia porteri | 4.25 |
| Pappophorum wrightii | 0.02 |
| Sporobolus spp. | 0.04 |
| Sporobolus cryptandrus | 0.06 |
| Sporobolus interruptus | 0.54 |
| Sitanion hystrix | 0.02 |
| Trichachne californica | 8.79 |
| Triodia mutica | 1.10 |
| Triodia pulchella | 3.00 |
| Unknown | 0.24 |

growth and the interval of line included in the intercept of the grass tuft on which the height measurement has been made. Height of stubble determines to which of the seven utilization classes each plant belongs. The intercept of the tuft measured on the line at ground level indicates the amount of ground cover. The total percent by classes is based on the relative portions of the intercepted grass tufts which belong in each stubble height class. Only six of the seven stubble height classes[1/] are represented this year. Drought conditions had resulted in shortened growth to the extent that there were no heights over 8 inches, so class 7 was omitted. Table 2 contains the percent utilization of perennial grasses in each height class by pastures. Percentage distribution of utilization by the various stubble height classes for the entire experimental range is as follows: Class 1, 3.5; class 2, 13.5; class 3, 29.7; class 4, 21.4; class 5, 8.6; and class 6, 23.3 percent.

1/ Culley's height classes incorporated in Canfield's Utilization Survey Working Plan, 1940, Santa Rita Experimental Range, unpub.

Table 2.-Stubble height classes by pastures in percent.

| Pasture numbers | Height class numbers | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| | Stubble height class intervals | | | | | |
| | 0-½" | ½"+-1" | 1"+2" | 2"+-4" | 4"+-6" | Over 6" |
| | Percent | Percent | Percent | Percent | Percent | Percent |
| 1 | 6.7 | 22.8 | 42.4 | 14.8 | 8.2 | 5.1 |
| 2 | 9.7 | 14.4 | 20.3 | 17.0 | 11.0 | 27.6 |
| 3 | 1.2 | 9.1 | 24.7 | 32.5 | 8.4 | 24.1 |
| 4 | - | 7.1 | 40.9 | 40.3 | 2.2 | 9.5 |
| 5 | - | 2.5 | 16.8 | 16.0 | 17.6 | 47.1 |
| 6A | 9.9 | 38.0 | 36.6 | 9.5 | 2.3 | 3.7 |
| 6B | 3.2 | 22.8 | 18.5 | 9.5 | 3.9 | 42.1 |
| 6C | 1.6 | 11.3 | 20.7 | 18.0 | 12.9 | 35.5 |
| 7 | 1.4 | 17.1 | 18.6 | 16.9 | 5.6 | 40.4 |
| 8 | 0.3 | 11.5 | 57.3 | 17.7 | 6.1 | 7.1 |
| 9 | 7.8 | 19.8 | 20.4 | 14.7 | 9.5 | 27.8 |
| 10 | 4.2 | 15.3 | 28.9 | 14.1 | 10.1 | 27.4 |
| 11 | 0.7 | 14.6 | 34.4 | 30.5 | 10.5 | 9.3 |
| 12A | 0.4 | 15.4 | 44.7 | 26.3 | 0.6 | 12.6 |
| 12B | - | 5.4 | 18.0 | 26.6 | 14.1 | 35.9 |
| 13 | 4.2 | 16.4 | 45.3 | 15.9 | 12.1 | 6.1 |
| 14 | - | 2.9 | 19.7 | 28.2 | 8.0 | 41.2 |
| 15 | 3.2 | 7.1 | 29.1 | 32.5 | 6.7 | 21.4 |
| 16 | 9.1 | 4.9 | 27.7 | 25.0 | 13.2 | 20.1 |

Grazing by species: Eight grass species which contribute most to the forage crop and occupy 4 percent or more of the total ground cover have been analyzed separately. Table 3 contains the results of these analyses. As all of these grasses are highly palatable to cattle and as precipitation during the growing season was below average, the large percentages of the grasses in stubble height classes 3, 4, and 5 reflect moderate utilization in a low-production forage year. Class 6 owes its high percentage largely to ungrazed plants which could not be eaten because of their inaccessibility.

Table 3.-Distribution of stubble heights for principal species in percent.[1/]

| Grasses | Height class numbers | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| | Stubble height class intervals | | | | | |
| | 0-½" | ½"-1" | 1"-2" | 2"+-4" | 4"+-6" | Over 6" |
| | Percent | Percent | Percent | Percent | Percent | Percent |
| Aristida | | | | | | |
| divaricata ..... | 4.35* | 4.35** | 17.39* | 47.83** | 13.00* | 13.00* |
| glauca ..... | 2.27 | 13.64* | 31.82* | 29.55* | 11.36* | 11.36* |
| Bouteloua | | | | | | |
| chondrosioides ..... | 8.45* | 25.35* | 46.48* | 15.49* | 1.41 | 2.82** |
| curtipendula ..... | 2.44** | 12.19* | 31.71* | 9.76* | 7.32* | 36.58* |
| eriopoda ..... | 3.45* | 17.24* | 24.14* | 18.96* | 6.90* | 29.31* |
| filiformis ..... | 3.85* | 23.08* | 39.42* | 15.38* | 6.73* | 11.54* |
| Other grasses | | | | | | |
| Muhlenbergia porteri..... | - | - | 14.29 | 9.52* | 9.52* | 66.71* |
| Trichachne californica ... | 2.27 | 6.82* | 15.91* | 25.00* | 13.64* | 36.36* |
| Hilaria belangeri ..... | 3.57 | 21.43*** | 53.57*** | 17.86 | 3.57*** | - |

1/ Levels of significance of percentages by "Fisher's t" are indicated by the following symbols:

* = .01
** = .02
*** = .05

Unmarked values are nonsignificant.

Southwestern

Starch Storage in Tanglehead Seedling. While the importance of starch reserves as related to the essential growth processes in plants has been generally known for some time, the conditions under which storage normally takes place in grasses have been only imperfectly understood until rather recently. The recent extensive work of McCarty showed that, with both perennial and annual grasses, carbohydrate storage is inversely related to growth rate and that there is no excess of food produced, and consequently no storage of food, during periods of active growth. The principles of this concept have been substantiated by other workers. Tests made with laboratory-grown seedings of tanglehead (Heteropogon contortus) indicate that this same relationship between starch storage and growth rate is exhibited by grasses during very early stages of growth.

In these tests material from the stem bases and upper portion of the roots of tanglehead seedlings at three different stages of growth was collected and tested microchemically for relative starch content. The plant material was sectioned on a microtome and the sections treated with IKI (iodine-potassium-iodide) solution. Relative abundance of starch and starch decomposition products (amylo-dextrin and erythro-dextrin) was determined microscopically from the abundance of blue and red staining granules present in the various tissues examined. The results of these tests are summarized in the following table.

From these tests it appears that some starch storage takes place any time that the rate of growth is retarded, as, for example, during short periods of drought, even though the plants have not completed a normal growth cycle. This is important in the Southwest, where the growth of range grasses during a normal summer season may be interrupted by recurrent short periods of unfavorable soil moisture.

With regard to the effect of grazing upon grass seedlings, the results of these tests indicate that in addition to the danger of being uprooted mechanically the young plants would be susceptible to serious physiological disturbance if grazed during the first growing season and prior to the time that some reserve food has been stored in the stem bases and roots to provide for the resumption of growth when conditions for such again become favorable.

Relative starch content of material from actively growing, semi-dormant, and completely dormant tanglehead seedlings.

| Age when tested | Treatment prior to starch tests | Stage of growth1/ | Relative abundance of blue and red staining granules | Location of starch and dextrins |
|---|---|---|---|---|
| 6 weeks | Watered adequately during entire 6-week period. | Rapid leaf growth. | Very scarce | Leaf mesophyll. Practically none in stem bases and roots. |
| 6 weeks | Watered adequately for 4 weeks. Not watered during last 2 weeks. | Becoming dormant due to lack of moisture. | Fairly abundant. | Leaf mesophyll. Vascular bundle sheathes. Cortex of roots. |
| 12 weeks | Watered adequately for 6 weeks. Not watered during last 6 weeks. | Completely dormant due to lack of moisture. | Very abundant. | All tissue tested. Most abundant in cortex of stem bases and roots. |

1/ None of the plants tested had produced flower stalks.

## COOPERATING BUREAU PROJECTS

### ENTOMOLOGY

(In cooperation with the Bureau of Entomology and Plant Quarantine)

#### Appalachian

Powder-Post Beetle Studies. Data were collected on the damage resulting to hickory sections infested from one to three years with Lyctus powder-post beetles. The data on damage were plotted against (1) the starch content of the wood at the time of infestation, (2) the month the tree was cut, and (3) the method used, and the length of time the logs were seasoned. Analyses of these data have not been completed.

Powder-post beetles were released for infestation in cans containing sections from hickories that had been cut during the past 3 years and seasoned by various methods for from 1 to 3 years, and in cans of hickory impregnated with various wood preservatives.

Wood Preservation Studies. The data from all the trees and posts impregnated with chemicals at Bent Creek for the past ten years were assembled, but final analyses have not been completed.

Healthy shortleaf pines 8 inches and 12 inches in diameter were treated with chemical preservatives in June. Logs from these trees will be used in service tests.

Southern Pine Beetle Studies. On the Bent Creek Experimental Forest 16 areas of pines killed by the southern pine beetle during the past two years were located, surveyed, and established as study plots. Among other things, these plots provide information as to the volume of timber killed by the insect and the plant succession following a bark beetle kill.

Insect Control. Inspections of numerous termite and powder-post beetle infested dwellings in and near Asheville were made during the period. For most of these dwellings commercial termite eradicating companies had made estimates for control. In every instance, the commercial concerns stressed chemical treatment, and in several cases suggestions for structural changes were avoided. Our inspections revealed that structural changes were advisable in all instances except one, that of a home made entirely of concrete and steel. Chemicals could sometimes be used as soil poisons but, for the most part, this was not necessary.

Northeastern

The tent caterpillar outbreak is practically at an end in Vermont and western Massachusetts. J. V. Schaffner, Jr., New Haven, Conn., reports that a series of sample plots, where observations have been made throughout the outbreak, were visited this spring to obtain data on the 1939 egg deposit. Because of the difficulty in making accurate counts of egg clusters in a limited time at each point, the number of egg clusters collected and actual time spent were recorded. This, of course, does not give definite information on the existing population, but taken over a period of years it shows the trend of infestation.

Below are listed the collection points and the rate per hour that egg clusters were collected for the years 1936 to 1939 inclusive. (The years in which eggs were deposited are listed, although the collections were made the following spring.)

| Town | 1936 | 1937 | 1938 | 1939 |
|---|---|---|---|---|
| Barre, Vt. (shade trees) | -- | -- | 98 | 3/ 6 |
| Bennington, Vt. (sugar orchard) | 1/61 | 97 | 16 | 0 |
| Bridport, Vt. (shade trees) | 86 | 49 | 2/-- | -- |
| Bristol, Vt. (shade trees) | 37 | 29 | 16 | 0 |
| Danby, Vt. (sugar orchard) | 82 | 38 | 12 | 0 |
| Dorset, Vt. (sugar orchard) | -- | 46 | 14 | 0 |
| " " (mixed hardwoods) | -- | 38 | 38 | 5 |
| Pawlet, Vt. (sugar orchard) | 1/49 | 29 | 38 | 11 |
| Randolph, Vt. (sugar orchard) | 1/52 | 72 | 26 | 5 |
| Richmond, Vt. (shade trees) | 1/ 5 | 8 | 0 | 0 |
| Springfield, Vt. (mixed hardwoods) | 1/54 | 40 | 28 | 15 |
| West Rutland, Vt. (sugar orchard) | 1/55 | 79 | 26 | 4 |
| Williamstown, Mass. (shade trees) | -- | 154 | 72 | 20 |

1/ Some trees severely defoliated prior to 1936.
2/ Trees were sprayed in 1938.
3/ Some of the trees sprayed in 1939.

An examination of the above table shows that there was a general decline in the infestation for most of the sample plots in 1938 and a very definite decrease in 1939.

Pales Weevil Injury to White Pine Seedlings in Hurricane-Swept Areas. H. A. Bess, New Haven, Conn., reports as follows on observations made during August to determine the extent of damage to white pine seedlings by the Pales weevil in areas where large numbers of white pines were blown down during the hurricane of September 21, 1938: A few quantitative data on the injury to natural pine seedlings in hurricane-felled pine stands during 1940 have been recently secured. In many of these areas 1-to 3-year-old seedlings are fairly abundant and in some small localized spots there are a number of conspicuous dead seedlings resulting from Pales weevil injury. However, these recent examinations indicate that there was comparatively little mortality this year from Pales weevil injury in three of the four areas studied. About one-half of the seedlings examined in the fourth area were dead. A summary of the data is given below.

| Location | Damage |
|---|---|
| Yale Forest, Swanzey, N. H. | 619 seedlings were examined: 41 were dead, 9 severely injured, 11 slightly injured, and 558 uninjured. Timber salvaged in 1939. |
| Mt. Toby State Forest, Sunderland, Mass. | No counts were made but hundreds of seedlings observed and very few dead ones were noted. Timber salvaged in 1939. |

| Location | Damage |
|---|---|
| Harvard Forest, Petersham, Mass. | No counts were made but hundreds of seedlings were noted and very few dead ones were seen. Timber salvaged in 1939. |
| Sibley Lot, Coldbrook, Mass. | 169 seedlings were examined in one area: 72 were dead, 13 severely injured, 5 slightly injured, and 79 uninjured. Timber salvaged in 1940. |

Large Proportion of White Pine Trees Still Alive in Certain Stands Blown Down by 1938 Hurricane. H. A. Bess, of New Haven, Conn., reports that a few of the unsalvaged hurricane-felled white pine stands in Winchendon, Mass., and vicinity were examined from time to time throughout this season for insect damage and salvageability. In the spring as high as 70 percent of the trees present were living and undamaged by insects. The conclusions drawn from these studies are that there was practically no further mortality of the trees this season and none of the living trees were injured by insects. Probably the relatively cool wet season prolonged the survival of these trees.

Heavy Spruce Bark Beetle Infestation in Crawford Notch. T. J. Parr, New Haven, Conn., after a survey of spruce areas on the White Mountain National Forest of New Hampshire and the Green Mountain National Forest of Vermont during the latter half of August, reports as follows on spruce bark beetle (Dendroctonus piceaperda Hopk.) conditions:

In New Hampshire, areas where the spruce bark beetle was present previous to the hurricane show no increase in infestation, either in standing or wind-thrown timber except in the Crawford Notch section. In fact, infestations have materially decreased or entirely disappeared in such areas as "The Bowl" at Wonalancet, Nancy Brook, near Bartlett, and Mt. Osceola, in Waterville Valley.

In the Beecher Brook drainage in Crawford Notch, where wind-thrown timber is now being logged, a small stand of approximately 10 acres of old, standing spruce, located above the present timber sale, was found infested. It was estimated that nearly 50 percent of the trees on that plot were attacked. On the opposite side of Crawford Notch a much larger area of mature spruce is heavily infested. On one survey strip in that area 10 chains long and 1 chain wide, 10 heavily attacked trees were found, or 10 trees per acre. Attacks were characterized by the absence of pitch tubes on the tree trunks. The insects were in all stages from eggs to adults. A 100-percent survey of this area, to determine the extent of the infestation and to mark attacked trees for subsequent removal, was recommended.

In Vermont, some increase in the number of infested trees was noted on the permanent 54-acre sample strip on Monastery Mountain. Eleven infested trees were found on this plot this year as compared

with 2 in 1939 and 8 in 1938. There was a proportionate increase in attached trees along the Long Trail from the junction of the Trail with the sample strip to Lake Pleiad. Only 2 attacked trees were found there in 1939, while 8 infested trees were spotted this year.

Southern

The termite shield tests were found in June to be almost a complete failure under all conditions and new tests were set up. These tests, namely, placing the shields directly on pieces of wood, are showing more promise than hitherto and will be enlarged. There have been more shelter tubes constructed by termites in the present set-up than in any of the three previous installations of these tests.

Johnson at Saucier, Miss., is making progress in his studies of the life cycle of ambrosia beetles and is finding quite a little activity of all species concerned near Saucier. The cellulose nitrate plastic ambrosia beetle cages have proved successful, more plastic has been obtained, and additional cages have been constructed. The large wood frame and cloth cage in the swamp is full of ambrosia beetle-infested logs and a wood planking path has been constructed to this cage and the light trap. Glass tube cages have been placed over individual beetle infestations in logs in the swamp. Observations of ambrosia beetles have indicated the following: In the case of Xyleborus affinis the adults apparently complete their life cycle in from 30-51 days, with an average of 41.6 days; and wide variations are found in the lapse of time between infestation and the appearance of adults in both the same and different species of ambrosia beetles. The adults remain in the tunnels for some time after completing their life cycle.

Christian has submitted a preliminary report on his tests, conducted in July and August, of chemical sprays to prevent attack by ambrosia beetles; several chemicals appear promising. A final paper by Christian on the biology of Lyctus powder-post beetles is in press.

In June, Wirka of the Forest Products Laboratory installed 140 test specimens of wood impregnated with a Swedish preservative at the Forest Products Laboratory in the ground at Saucier, Miss., to determine its resistance to termites and decay. This preservative consists of zinc, arsenic, and chromium salts and is patented by the Boliden Mining Company of Stockholm. A duplicate set will be tested in Panama.

In June a first-year progress report on the service tests at Saucier, Miss., of the preservative value of various integral poisons in the Johns-Manville fibre boards was submitted to this company, with a copy to Washington, D. C. A duplicate set is under test in Panama. Additional tests of pentachlorphenal were installed at Saucier in June.

The State of Louisiana has an appropriation of $15,000 for the control of the Texas leaf-cutting ant, with particular reference to the protection of agricultural crops; since these ants inhabit especially areas of waste or cutover land where there are poor soils, some control work will be conducted on potential forest areas. The State Entomologist has requested the State Forester to cooperate in

locating the nests of this ant and this office will also cooperate in an advisory capacity. It is hoped that the State can also test some of the ten non-inflammable and non-explosive chemicals which we intend to test in cooperation with the Federal Forest Service next fall on the Kisatchie National Forest.

During September the cooperative soil poison, fibre board poison, and wood preservative tests near Crown Point, La., and Saucier, Miss., were inspected and reports on the results were prepared for the files. Additions were made to these tests at Saucier.

## PATHOLOGY
(In cooperation with the Bureau of Plant Industry)

### Appalachian

Study of the Little-Leaf Disease. Work on the little-leaf disease has been organized with the addition of 3 technical men headquartered at Athens, Ga. The disease is known to extend from northeastern Mississippi through the Piedmont to Rutherford County, N. C., with an additional area in central Virginia. The situation is most acute in Alabama, and the first work has been centered there. Plots in severely diseased, lightly diseased, and disease-free areas have been established in the vicinity of Dadeville and Birmingham, Ala. Similar sets of plots will be established in many other sections of the little-leaf belt. A critical study of the root systems of healthy and little-leaf trees, and associated fungi, is under way. A soil survey of the little-leaf belt has been started, in an attempt to discover any soil differences between areas with healthy and little-leaf trees, that might explain the difference in condition of the trees. Detailed stem and foliage analyses have also been started in order to understand thoroughly the symptom complex and to be able to separate little-leaf trees from those suffering from poor site conditions and other abnormalities.

Five-year field records were taken on the following types of oak plots in northern Virginia: (1) the healing of wounds made when one of a pair of twin trees was removed and the development of decay from the wounds; (2) the effect of girdling companion sprouts or cutting off at breast height; (3) the effect of season of cutting on the height of sprout origin on the parent stumps; (4) the development of sprouts where trees were cut off flush with the ground; (5) healing and decay in oak pruning wounds. A 5-year report will be issued on the results of these records.

Central States

The forest nurseries in this region have all been visited once this season, and most of them have been visited several times. Few disease problems were observed in the nurseries, and in most instances the seedlings were found to be growing well. Only one serious disease epidemic occurred, and it may be possible to prevent similar trouble in the future through modification of nursery practice. It seems probable that this freedom from serious disease problems is due largely to information secured from research and experience in past years.

Dayton Elm Disease. The seriousness of the so-called Dayton elm disease or phloem-necrosis became evident in Columbus during the summer as scores if not hundreds of park and yard trees thinned in their crowns, cupped their leaves, dropped them as they yellowed, and died. Trees of all sizes and ages are susceptible. During a visit by representatives of the Bureau of Entomology's Elm Disease Laboratory, it was learned that the phloem-necrosis attacks principally the white or American elm and that relatively few infections have been found to date on other elms, such as the slippery elm. The areas of infection are very patchy, with practically no known occurrences north of Columbus. At the present time the disease is found to the south and east, to the south and west, frequently along stream margins, and on flood plains. There is a patch at Belpre, on the Ohio River, but none among the splendid elms at Marietta, Ohio, nearby up the river. It occurs in portions of Kentucky, through portions of Indiana, and even out into Illinois, where a bad patch occurs near Danville on the state line.

It is not known how the phloem-necrosis is transmitted, but certain insects are suspected. Experimental work is shaped to discover if this is true, and to find out the carrier and mode of transmission, if possible. No results are available to date, another growing season being needed to provide results from this season's activities.

Northeastern

Fomes pini. Investigation of complaints received from two widely separated localities, concerning heavy cull from rot in extensive, living, eastern white pine stands 100 or more years old, has revealed red ring rot caused by Fomes pini as a serious economic factor with this important timber species. In one case attack may have resulted from breakage of branches in removing intermixed spruce and balsam fir a number of years ago. In the other case, poor site seems to have favored the trouble.

The red ring rot has been found generally distributed in the older white pine trees destroyed by the hurricane. In connection

with this rot, the question has been raised whether the rot could have advanced unduly in water-stored white pine logs. Reasoning from the fact that such logs have become heavily water-soaked, in which state no wood rot is known to progress appreciably, the answer was given that rot could not have extended to any extent since the logs were placed in the water.

Southern

The study of fungi associated with stain in chemically treated green lumber has been completed and a manuscript accepted for publication. There apparently is not a sufficiently specialized flora on treated wood to account for occasional failures of commercial chemicals to control stain. These failures apparently are due mainly to poor handling practices or sometimes to adverse weather.

A survey of building decay conditions in Florida was made with Dr. Richards of the Madison branch. There was everywhere noticed marked trends toward better building practices as far as decay susceptibility is concerned. Particularly encouraging was the increased availability to the retail trade of lumber treated with inorganic salt preservatives and the increased use of such material in house construction.

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